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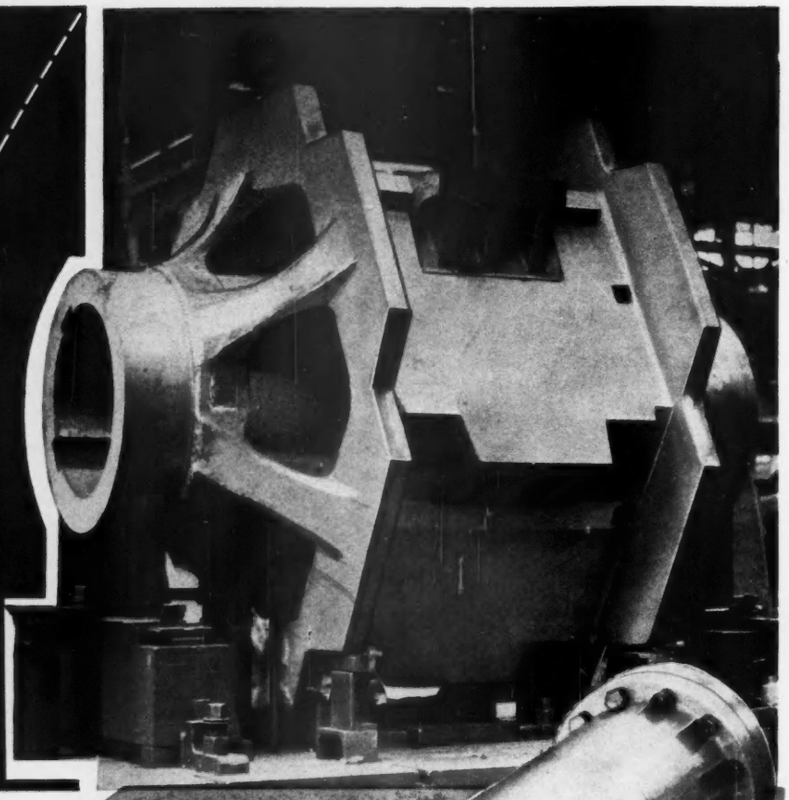

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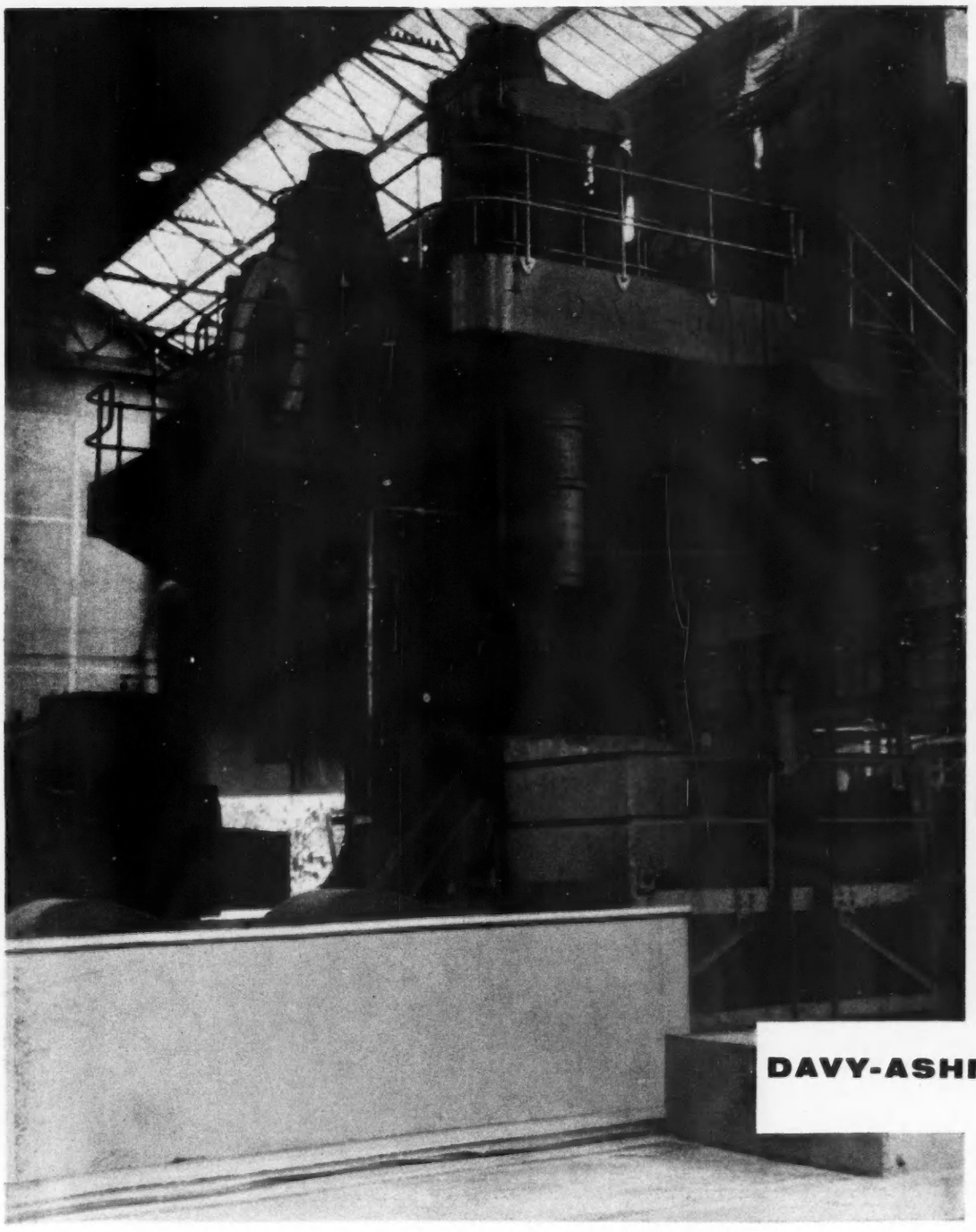

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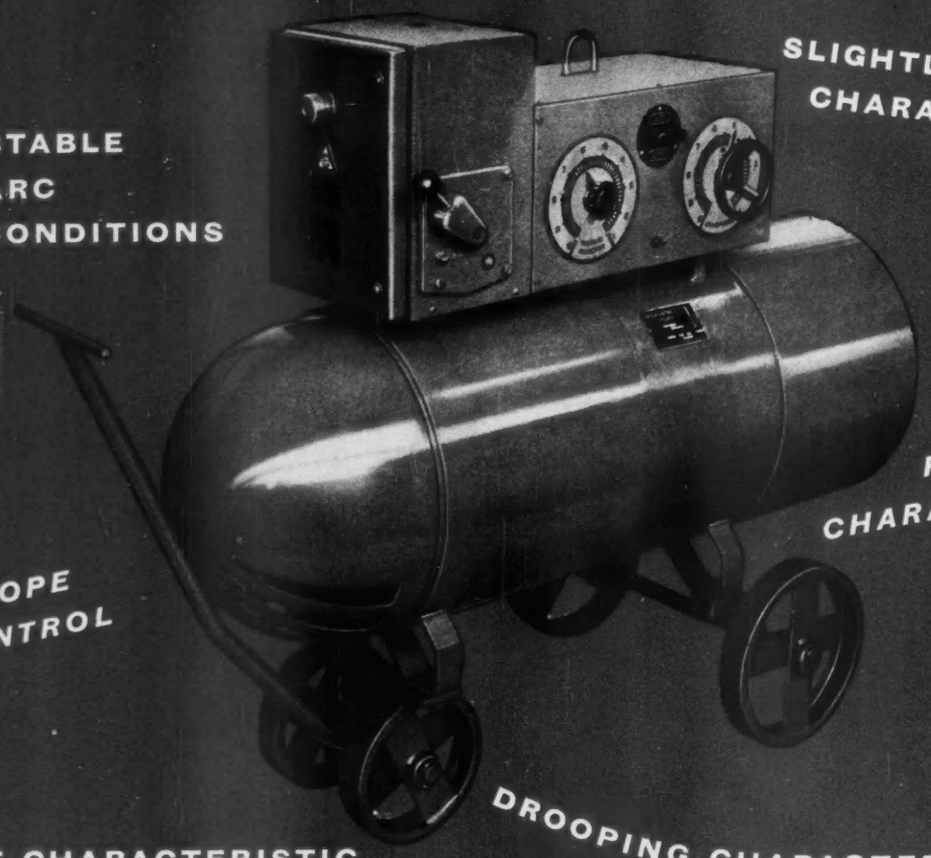

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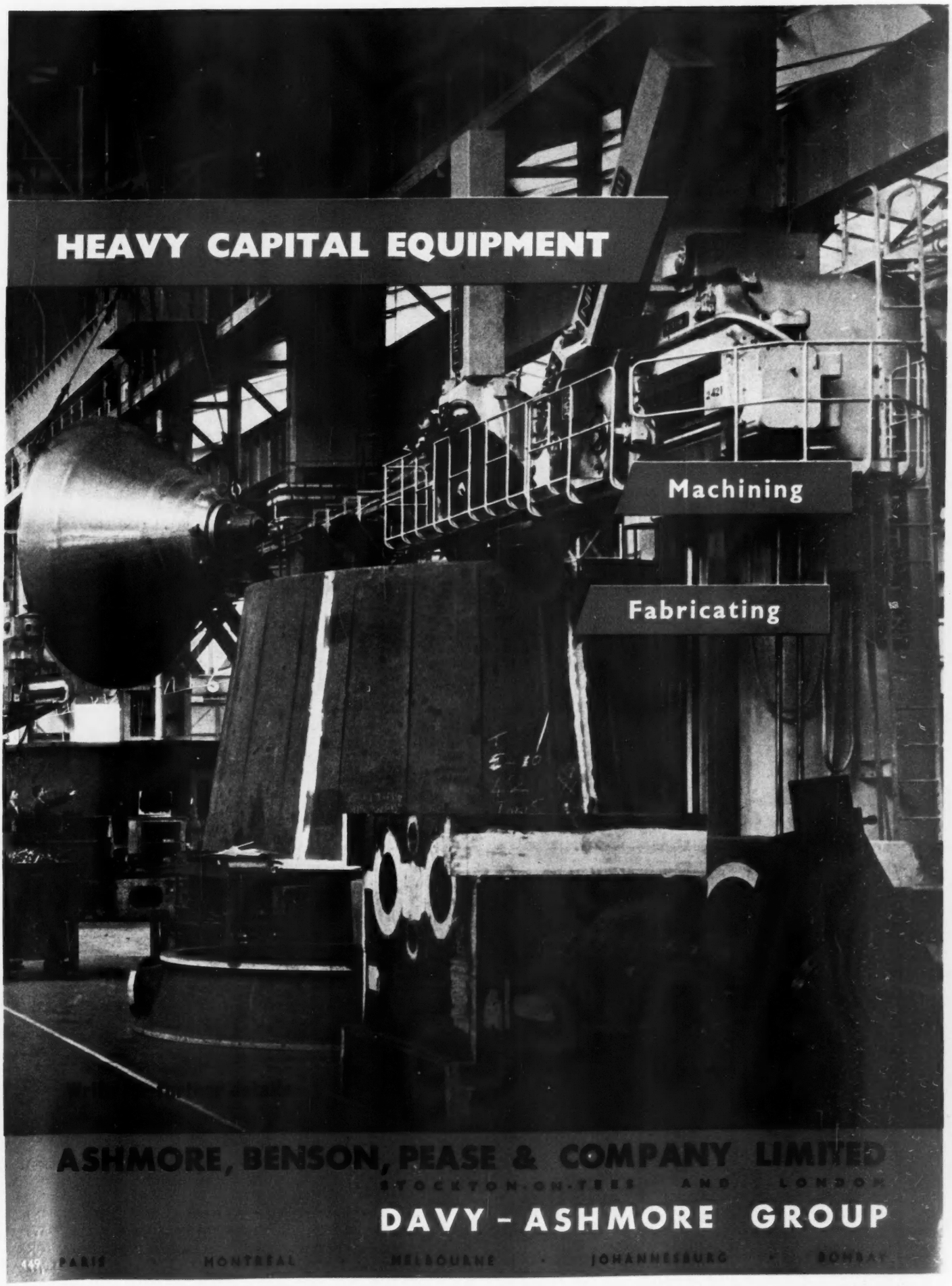
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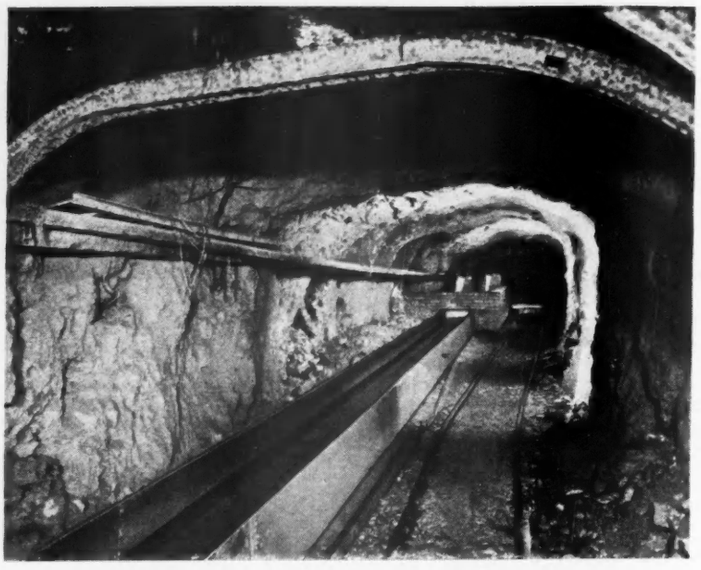

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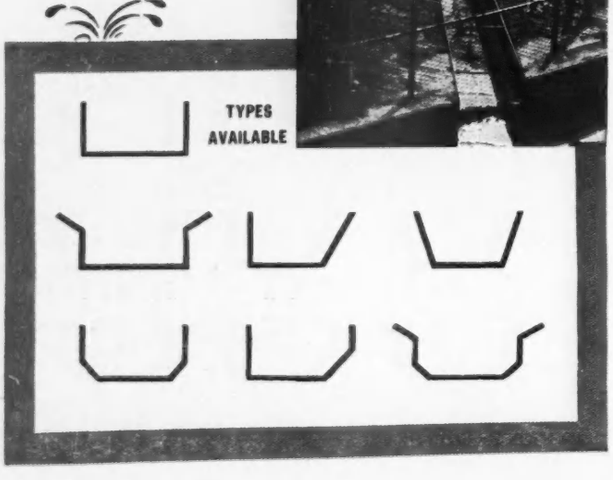

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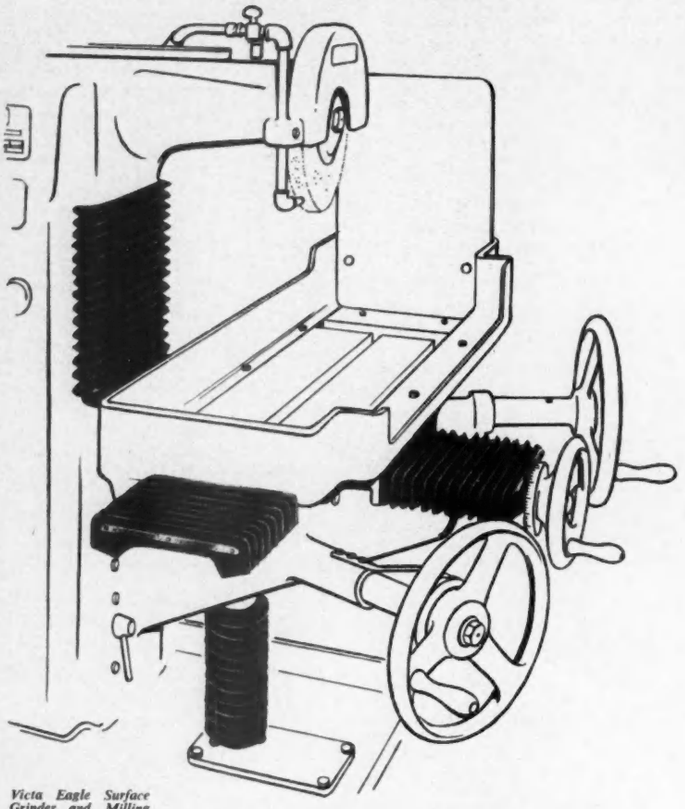

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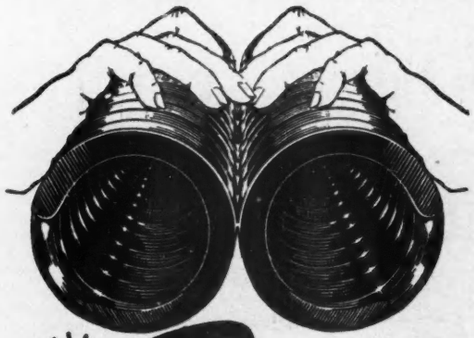

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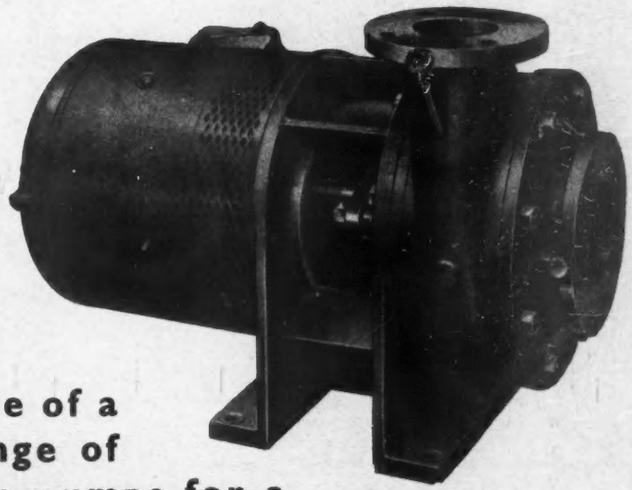

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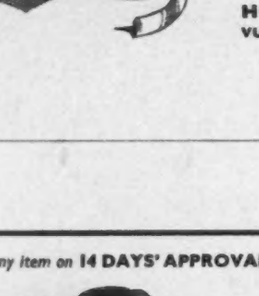

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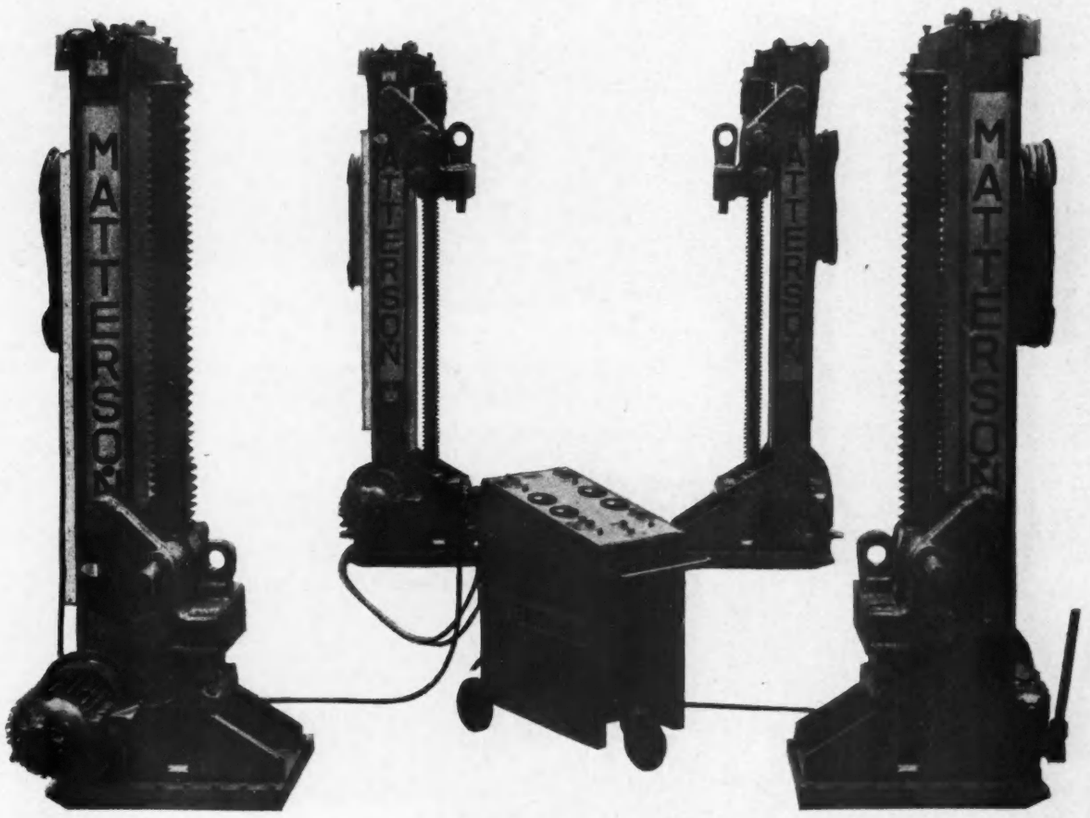

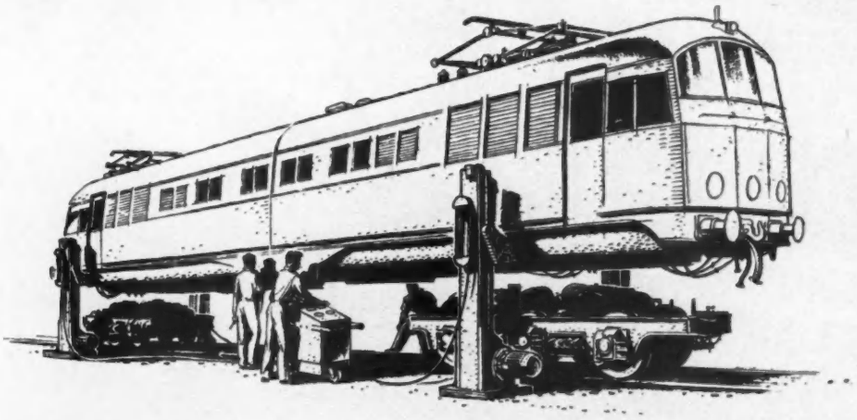

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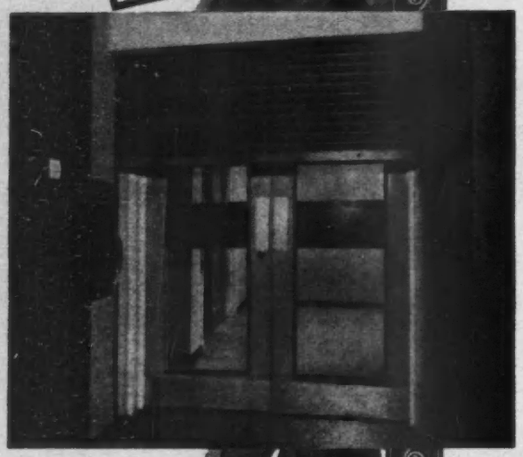

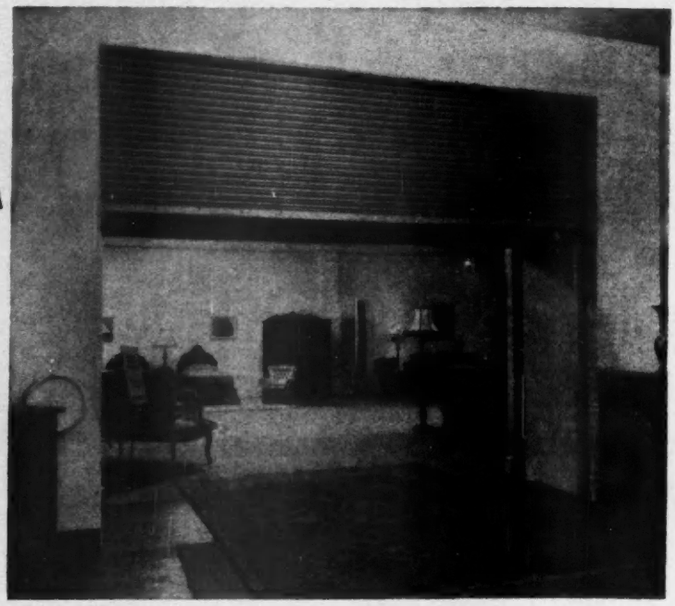

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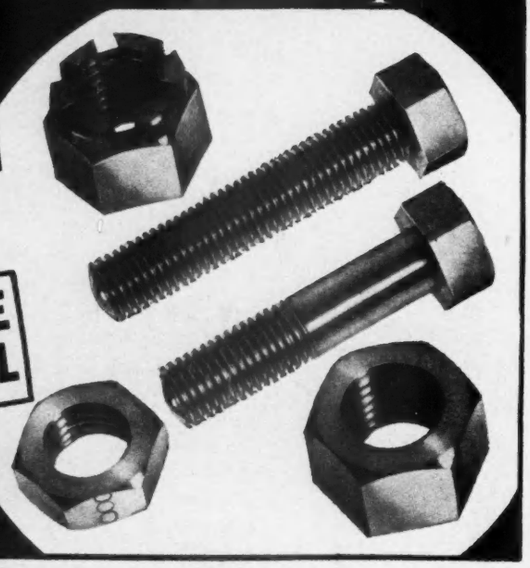

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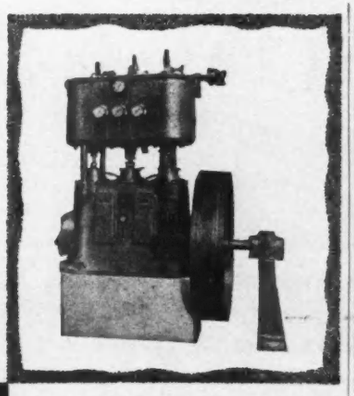

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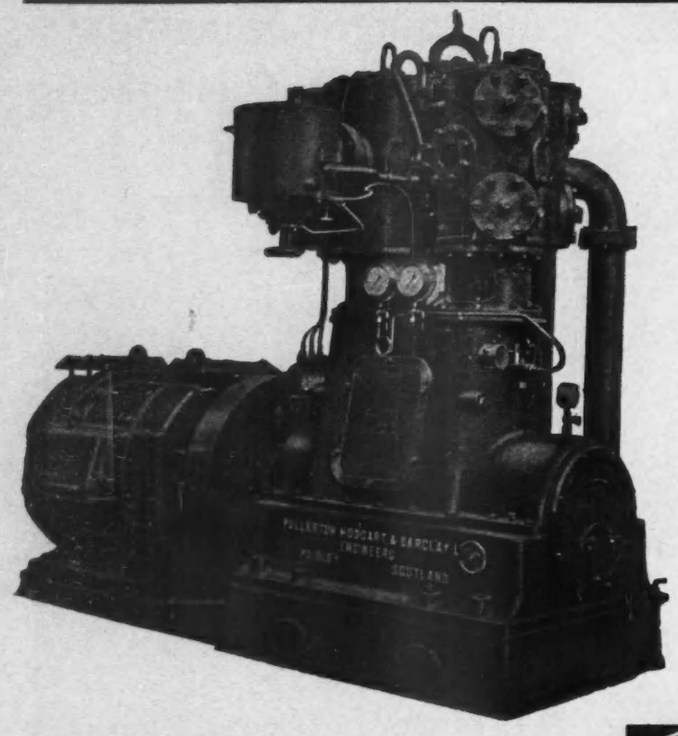

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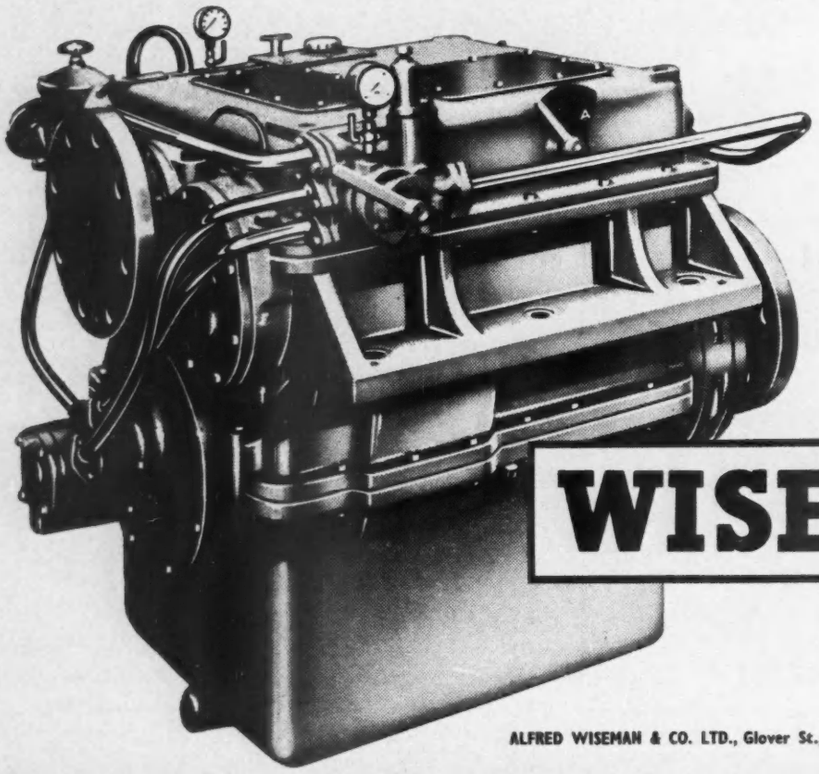

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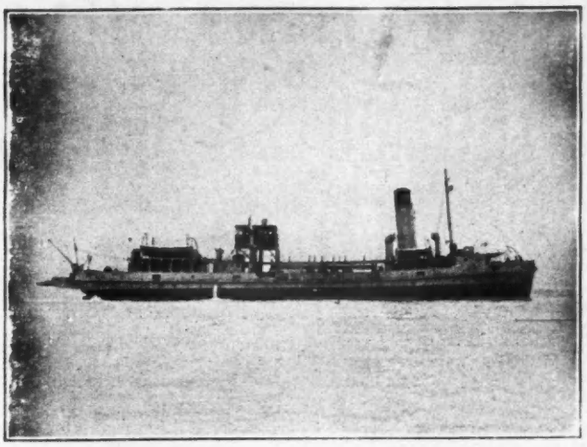

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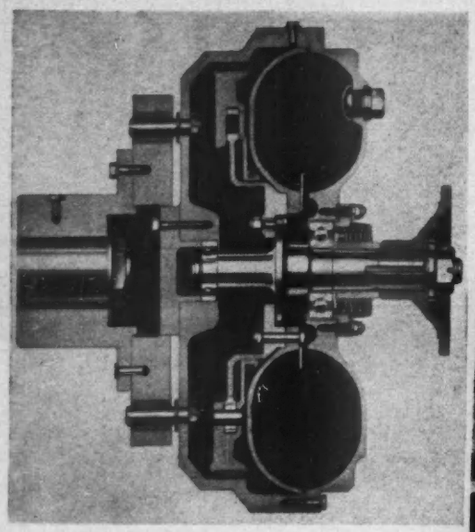

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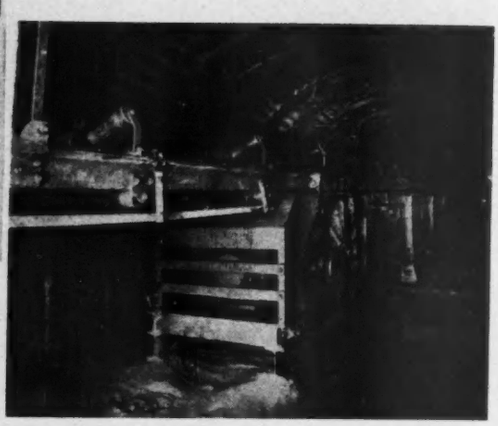

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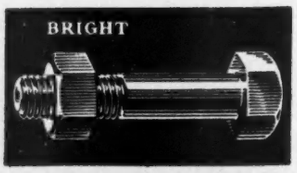

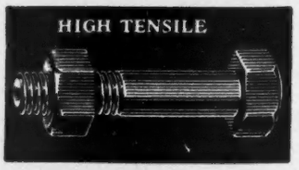

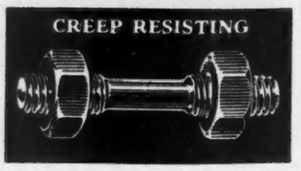

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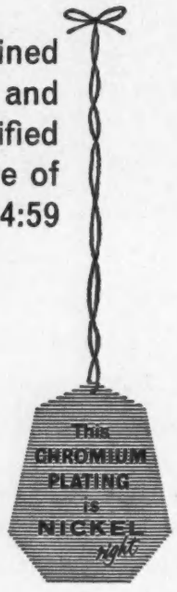

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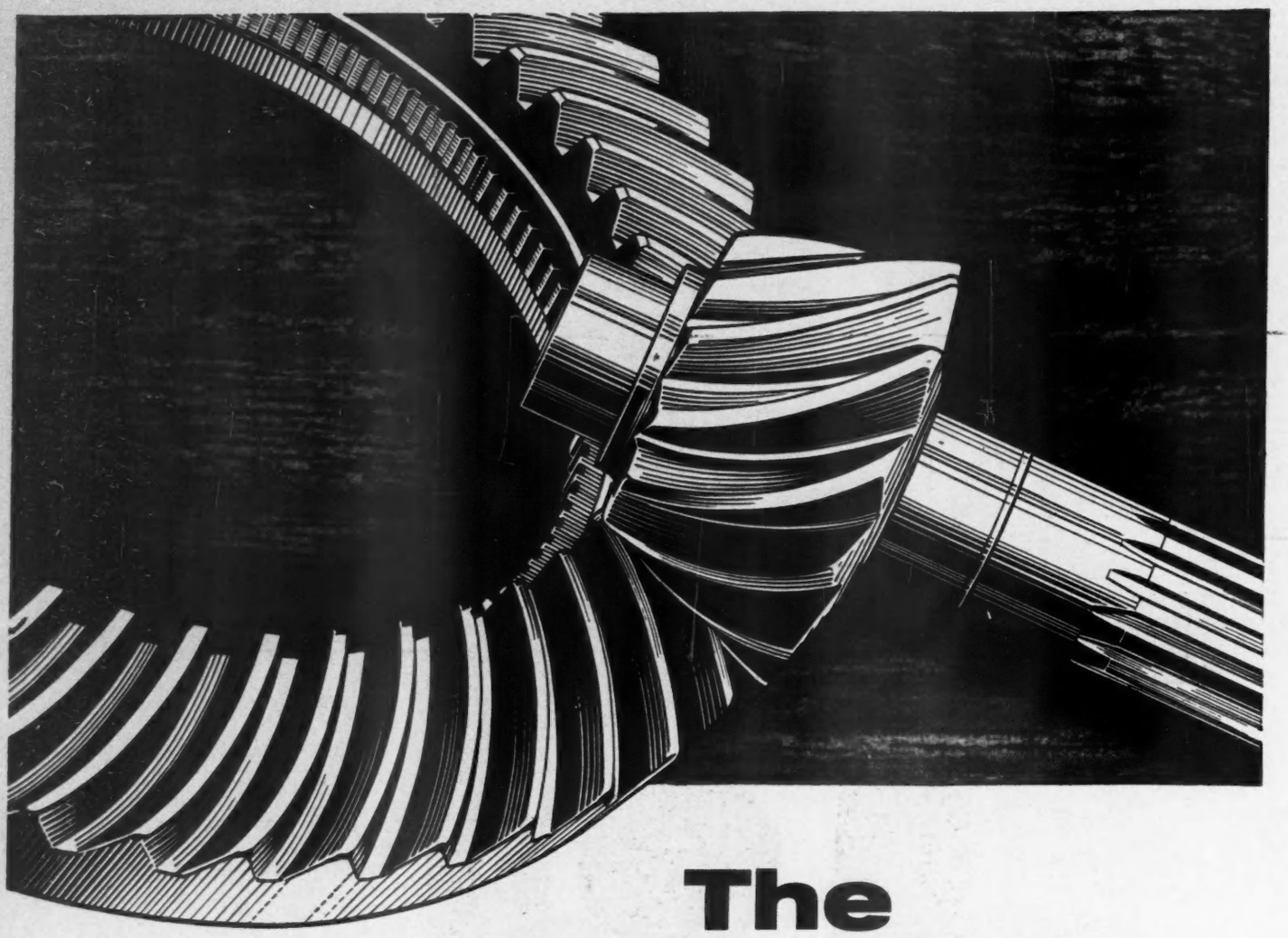

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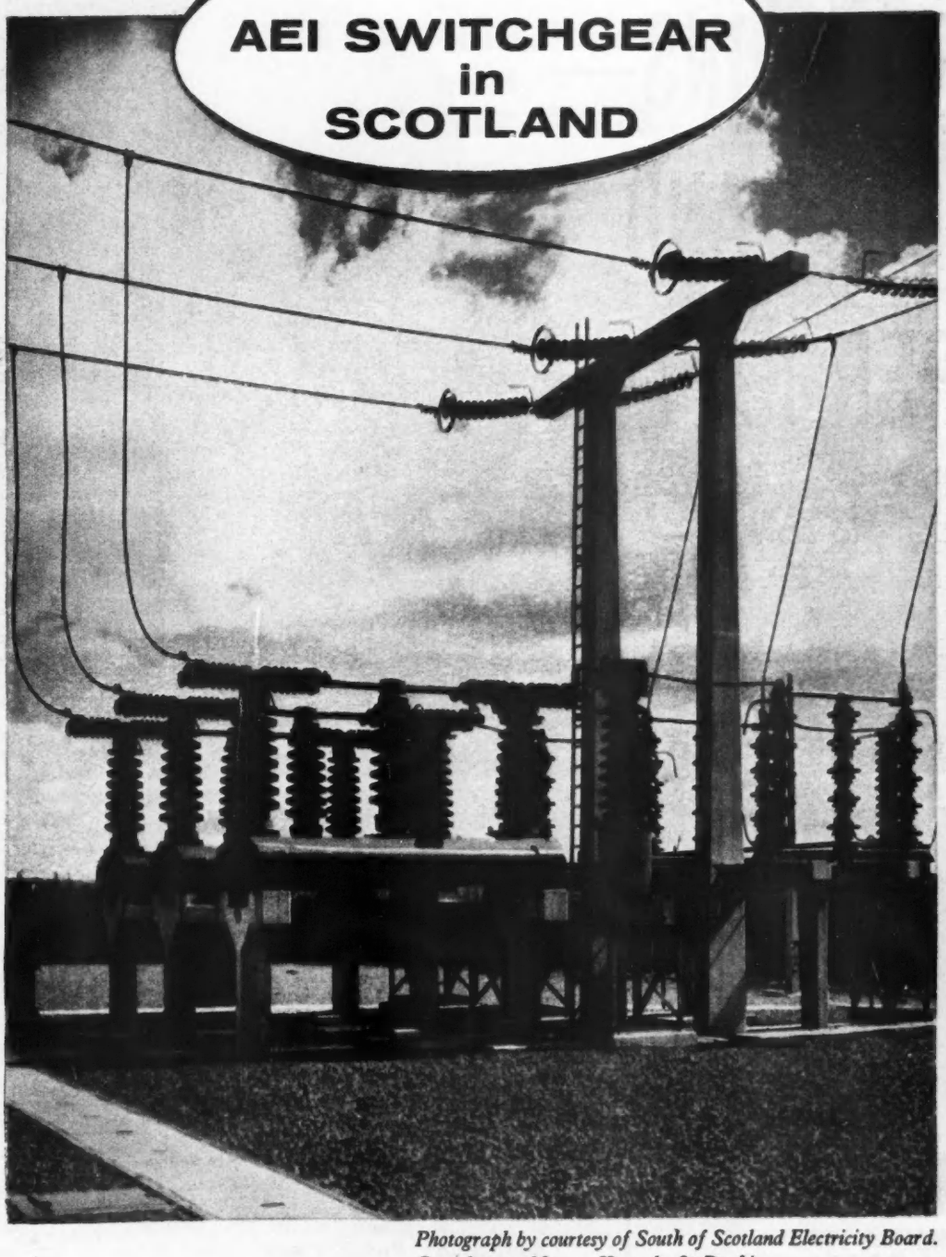
AEI SWITCHGEAR in SCOTLAND



Photograph by courtesy of South of Scotland Electricity Board. Consultants: Messrs. Kennedy & Donkin.

This twelve-switch, outdoor switching station at Neilston, Renfrewshire (South of Scotland Electricity Board) is equipped with air-blast circuit-breakers of the type GA6W4, with a rating of 132 kV—3500 MVA, manufactured by AEI. Two further circuit-breakers of the same type are to be added. These will control the 132 kV side of the two 'Supergrid' transformers which will be installed in the adjacent 275 kV Sub-station. In addition, outdoor current-transformers and extensions for the existing control and relay boards will be supplied.

The generating station at Kincardine-on-Forth is similarly equipped with AEI switchgear, to the order of the South of Scotland Electricity Board. These installations will link up with the projected 275 kV scheme in South Scotland.

For further details, write to AEI Switchgear Division, Trafford Park Manchester 17 or to your local AEI Office.

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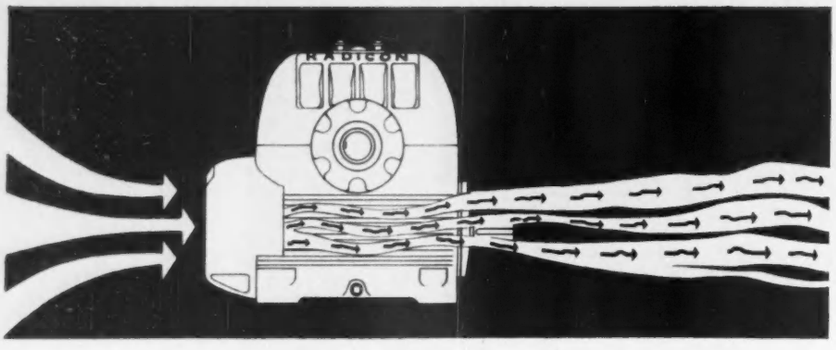

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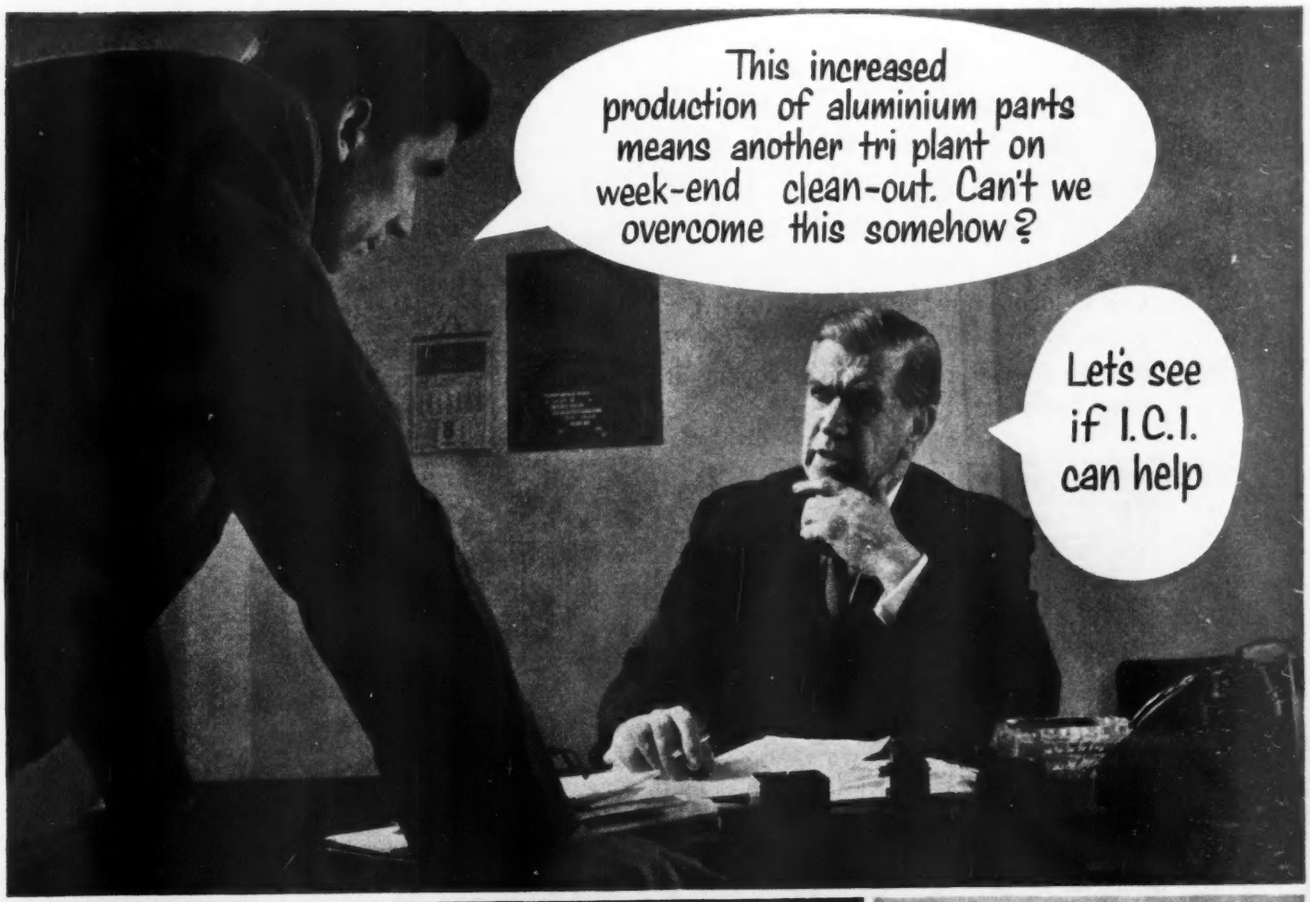
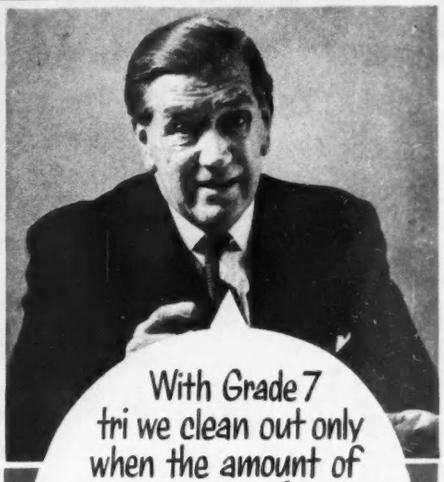

This increased production of aluminium parts means another tri plant on week-end clean-out. Can't we overcome this somehow?
Let's see if I.C.I. can help



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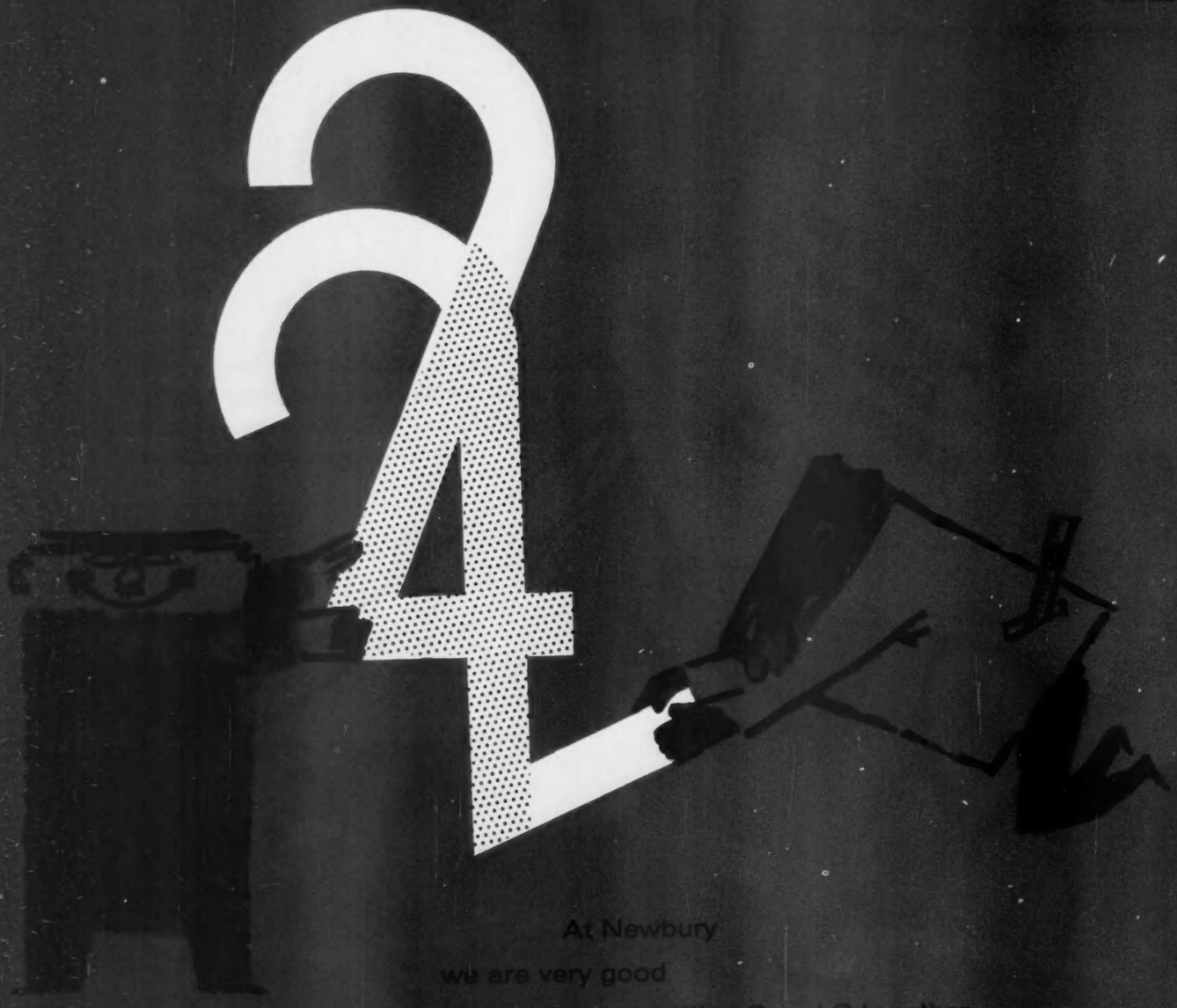

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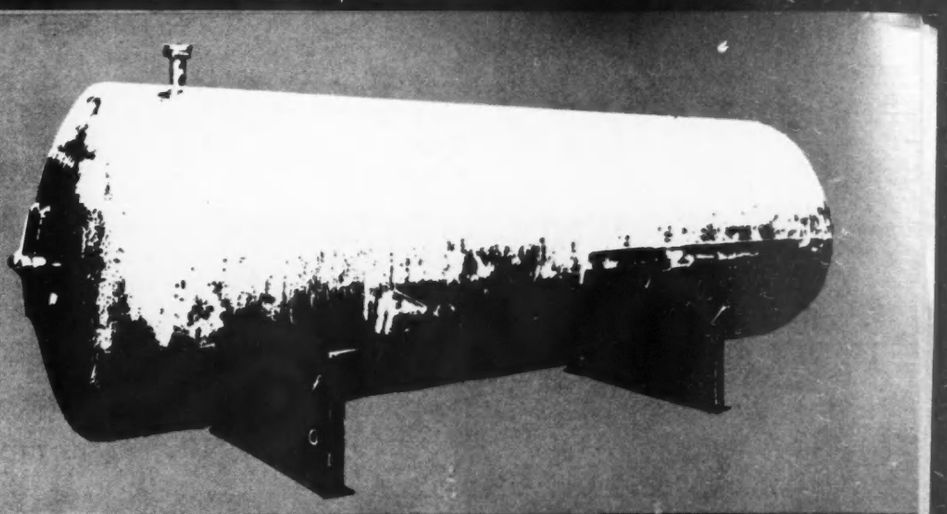

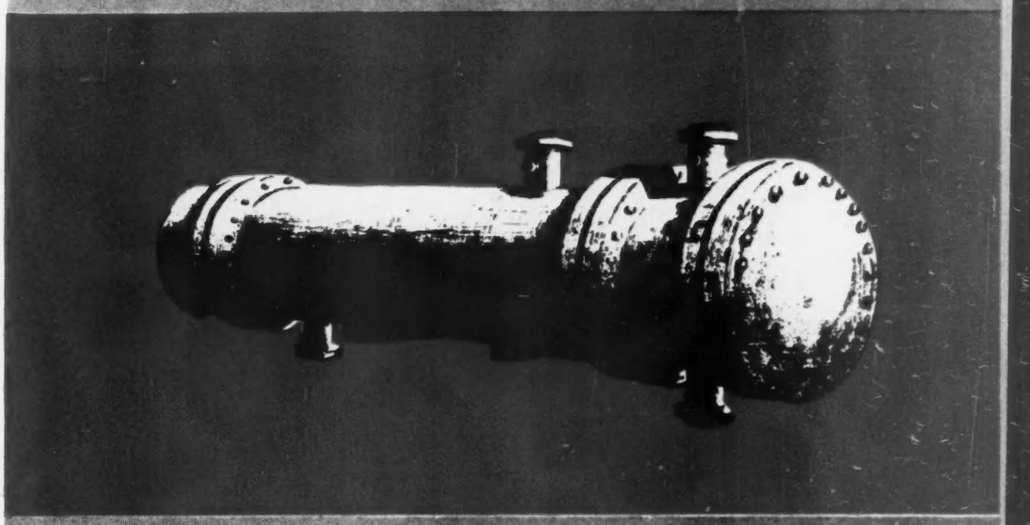

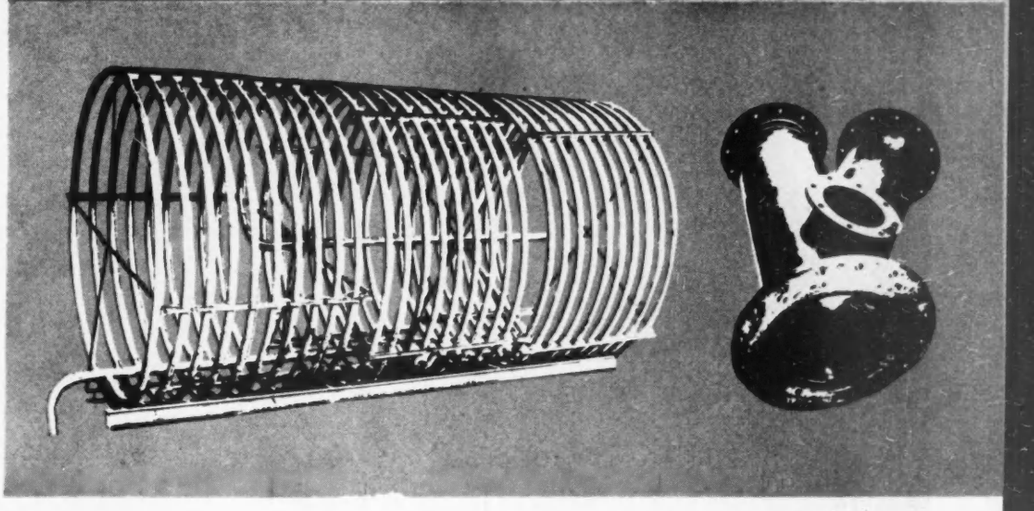

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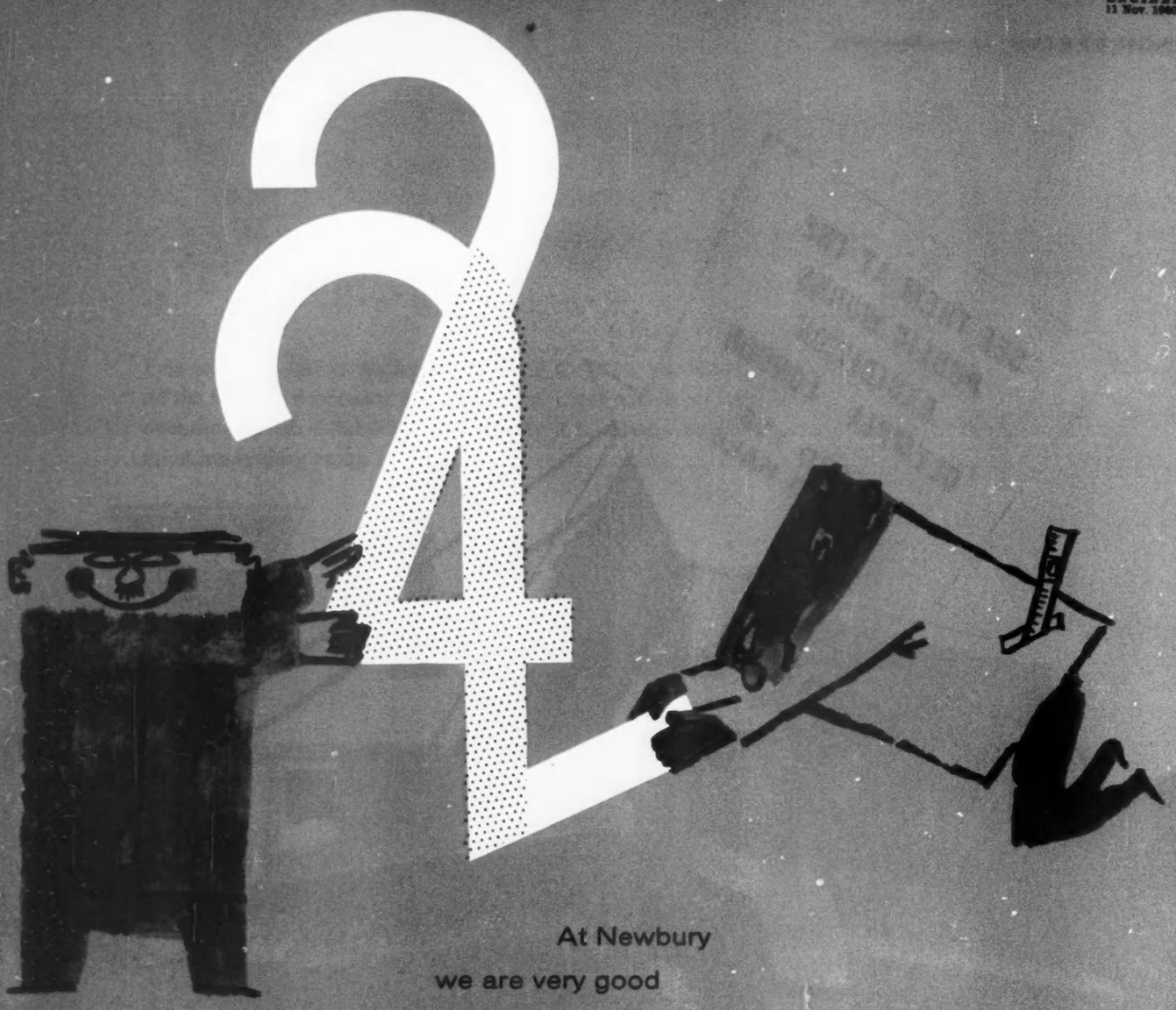

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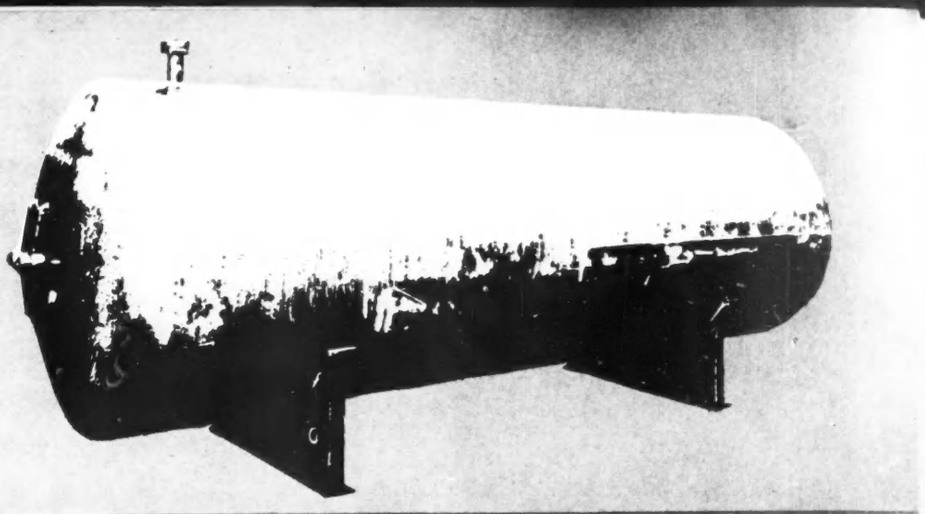

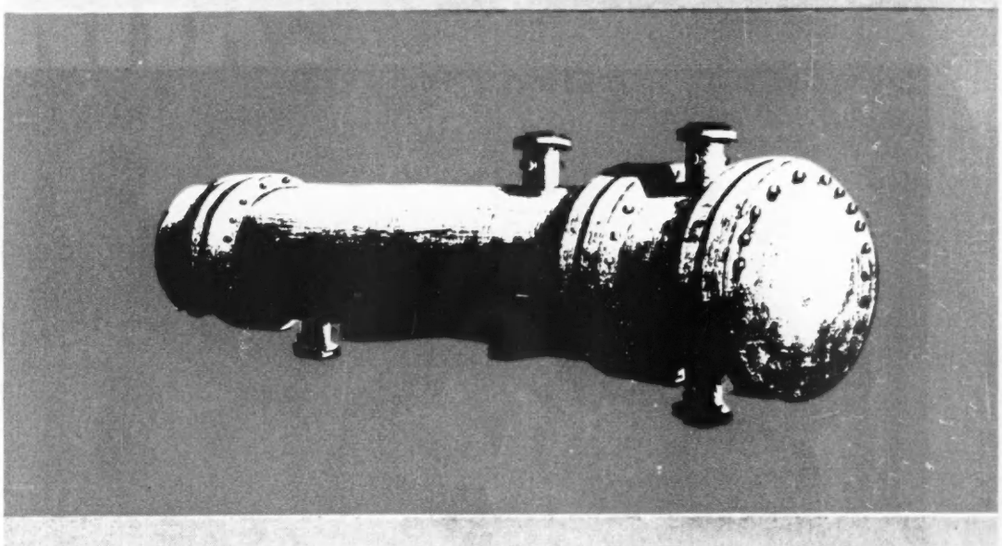

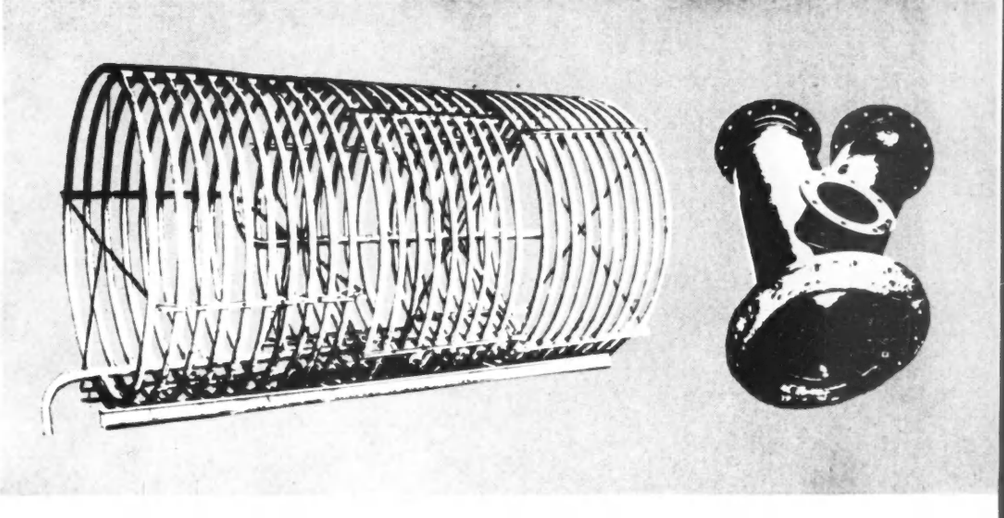

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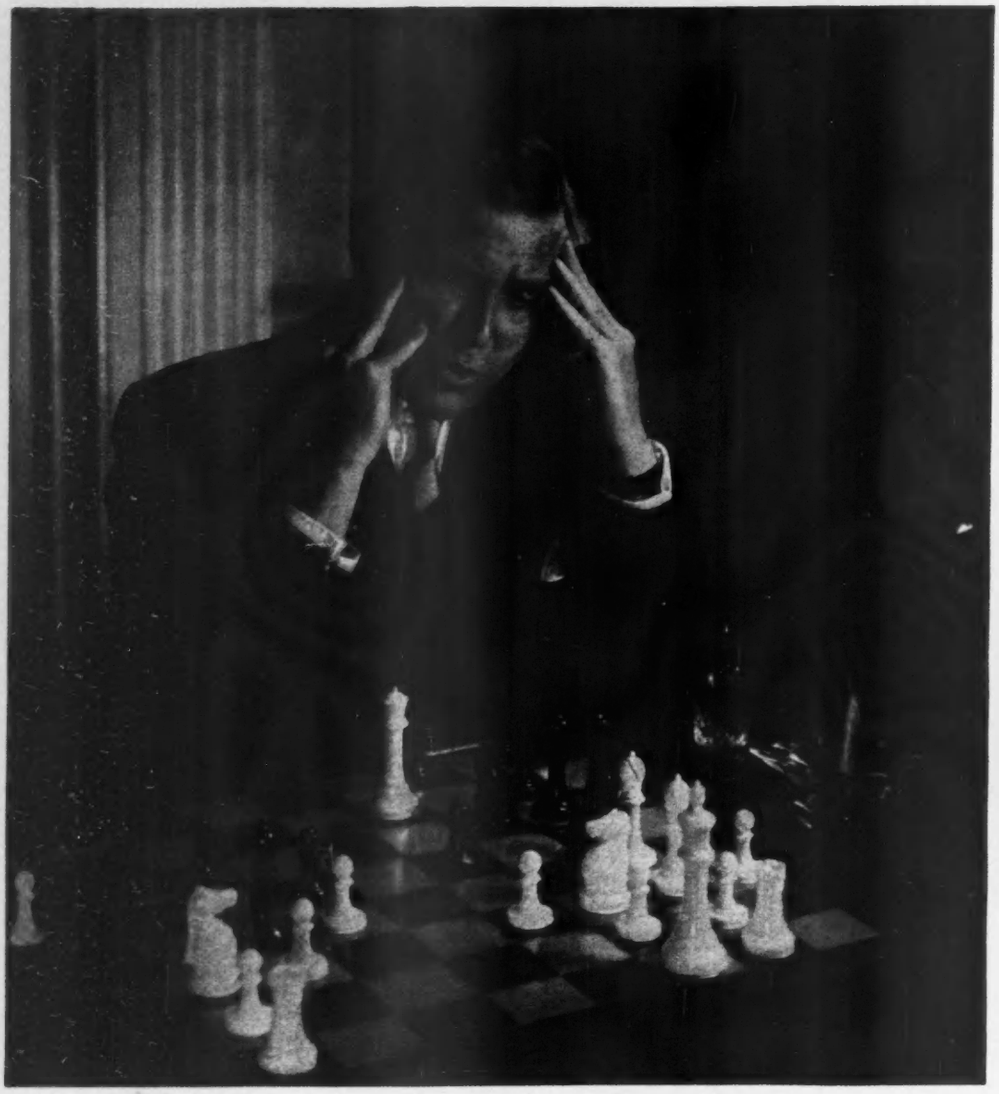

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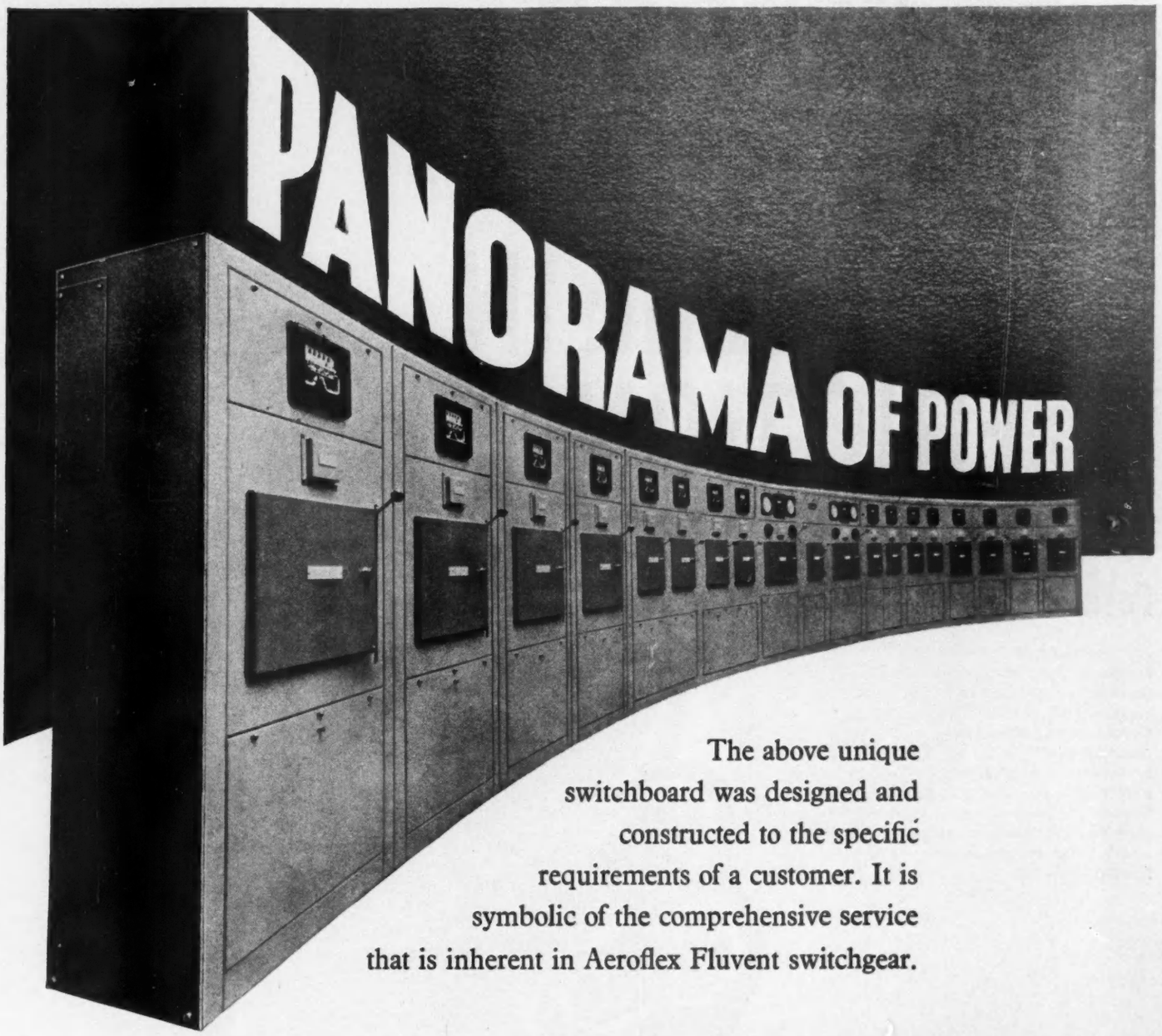

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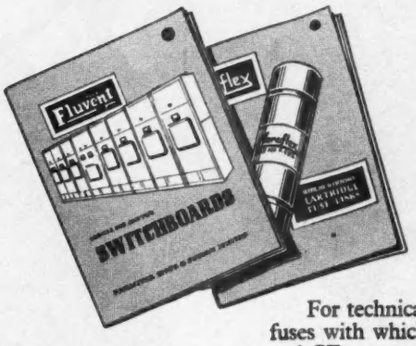

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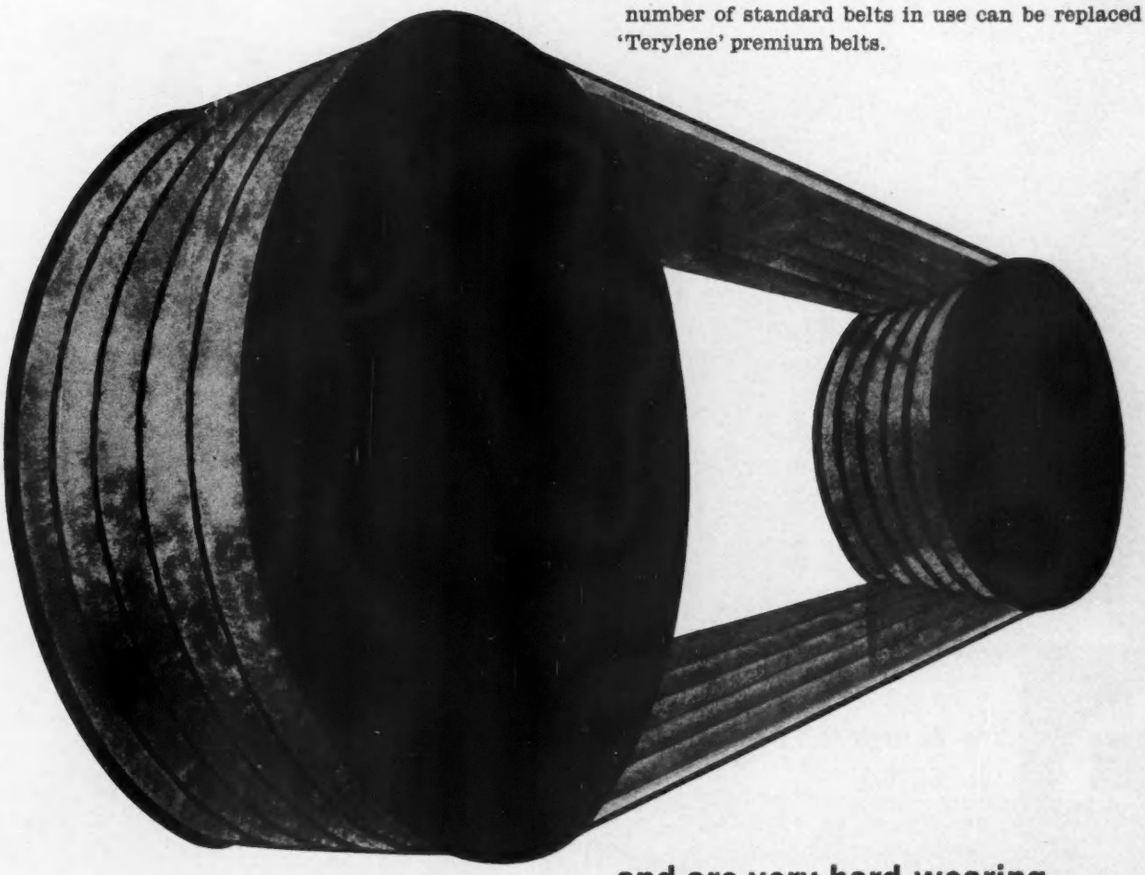

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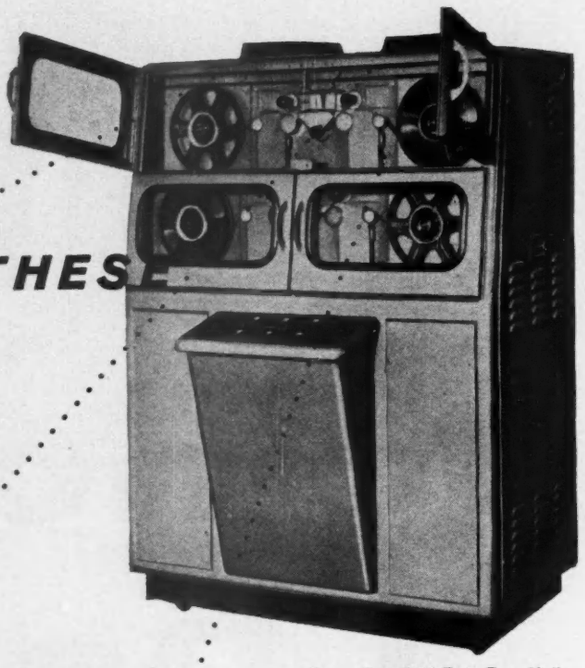
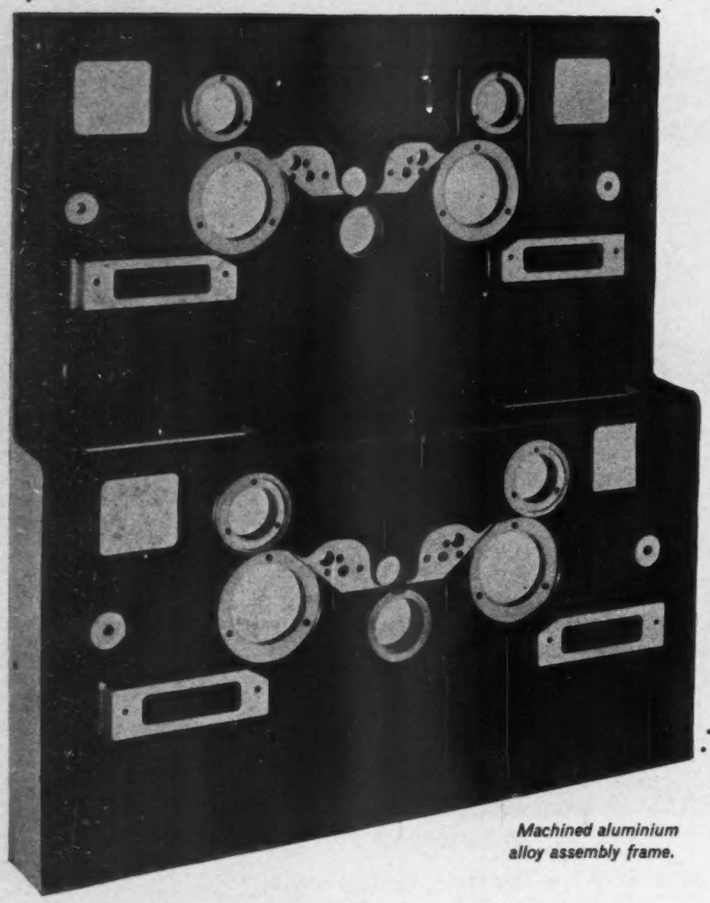


Decca Type 3000 Twin Tape Unit



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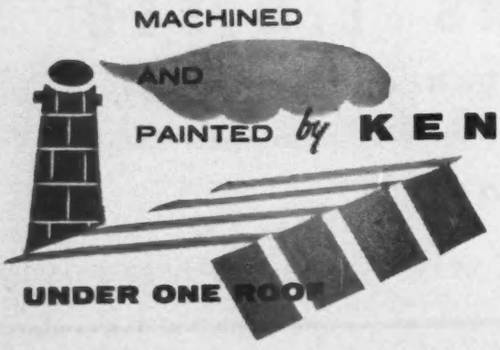

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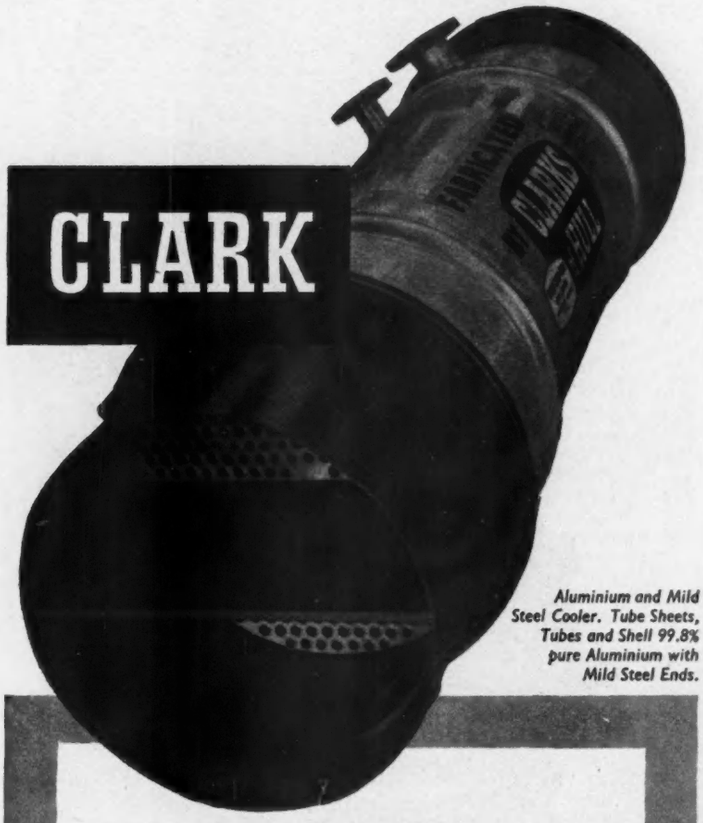

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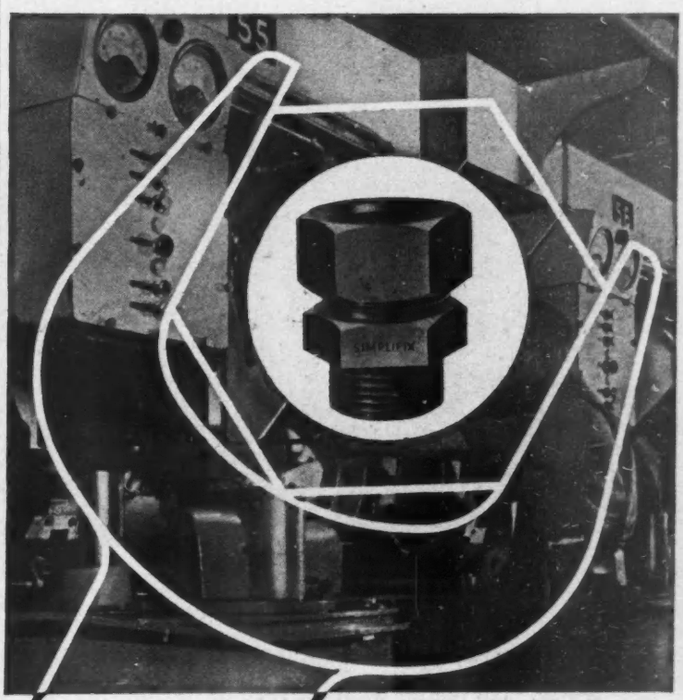

The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.

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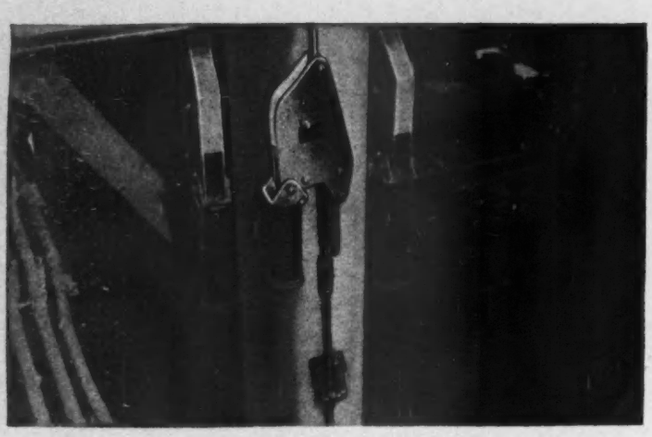

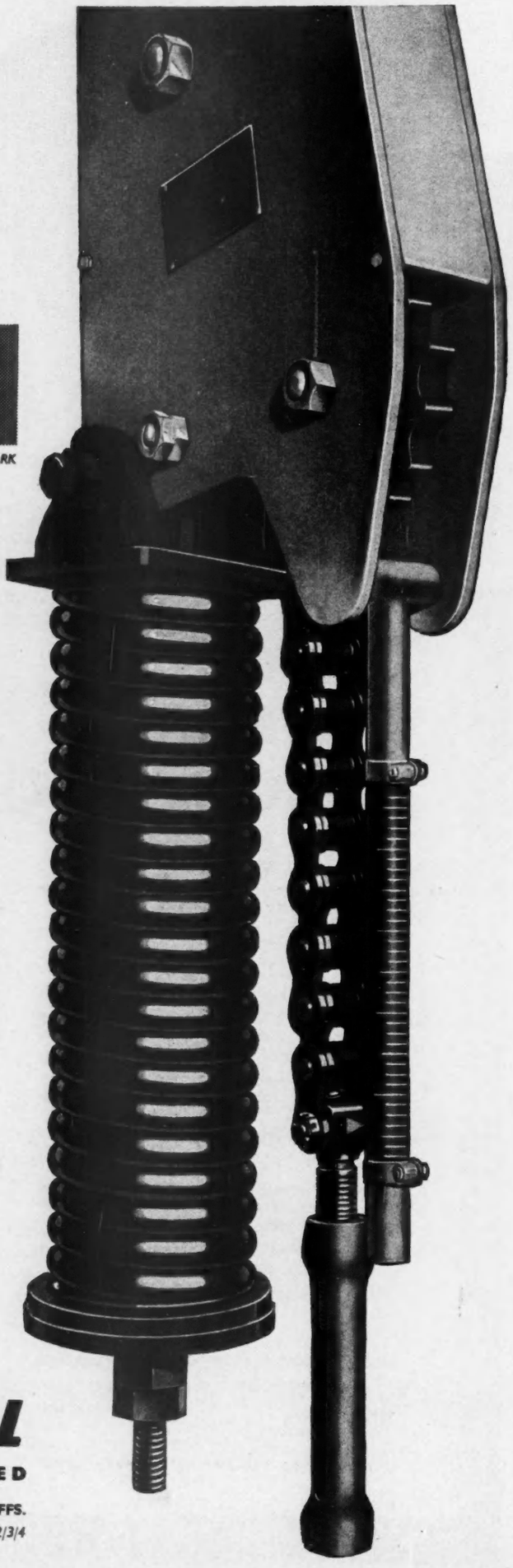

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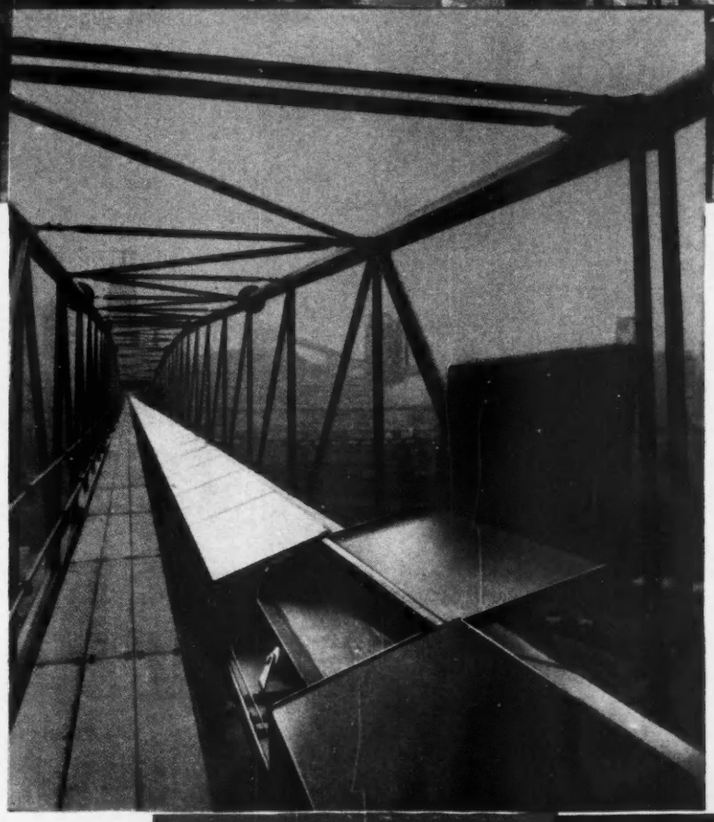

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The photograph shows two 2200 kW pass-out turbines

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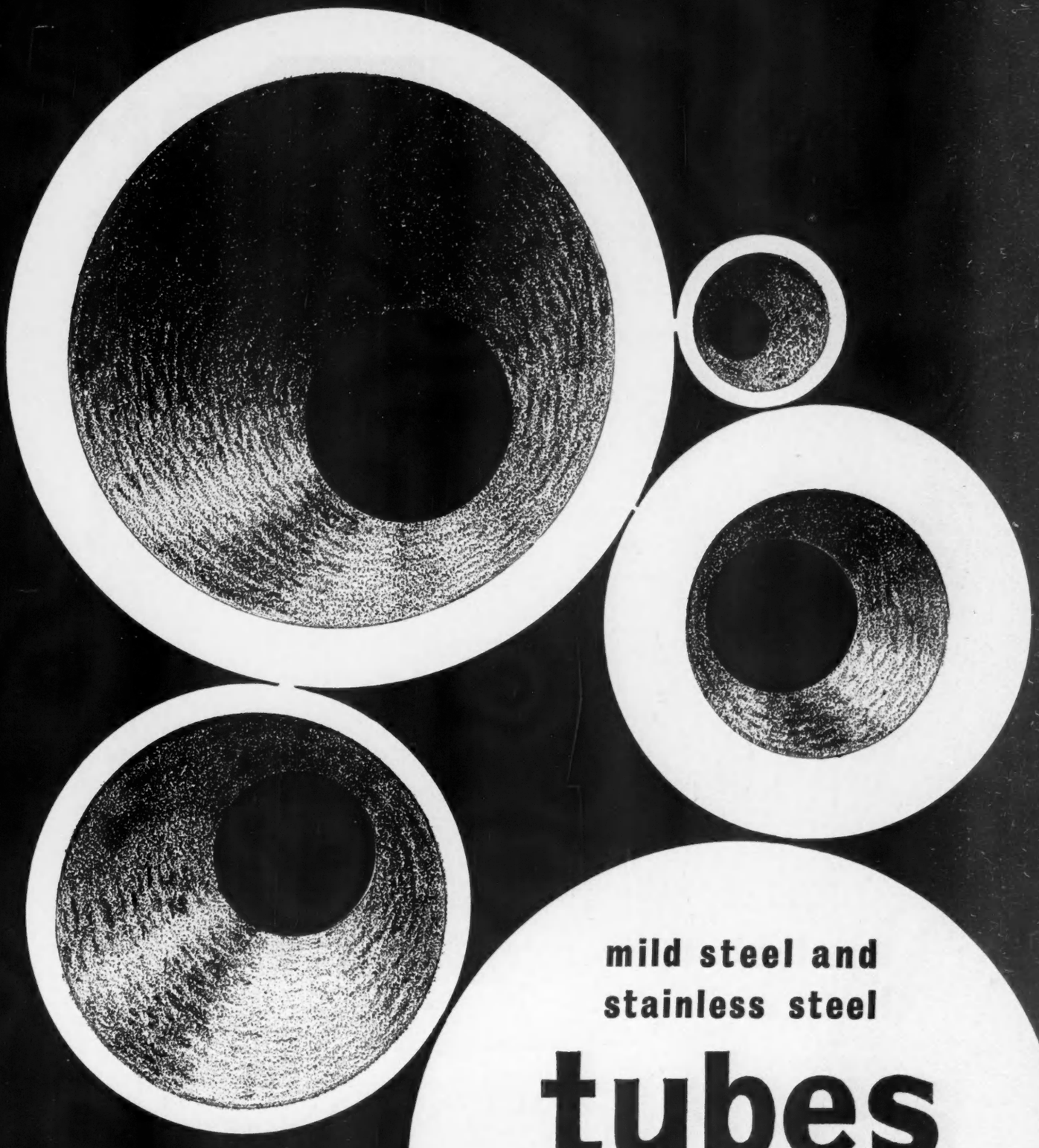

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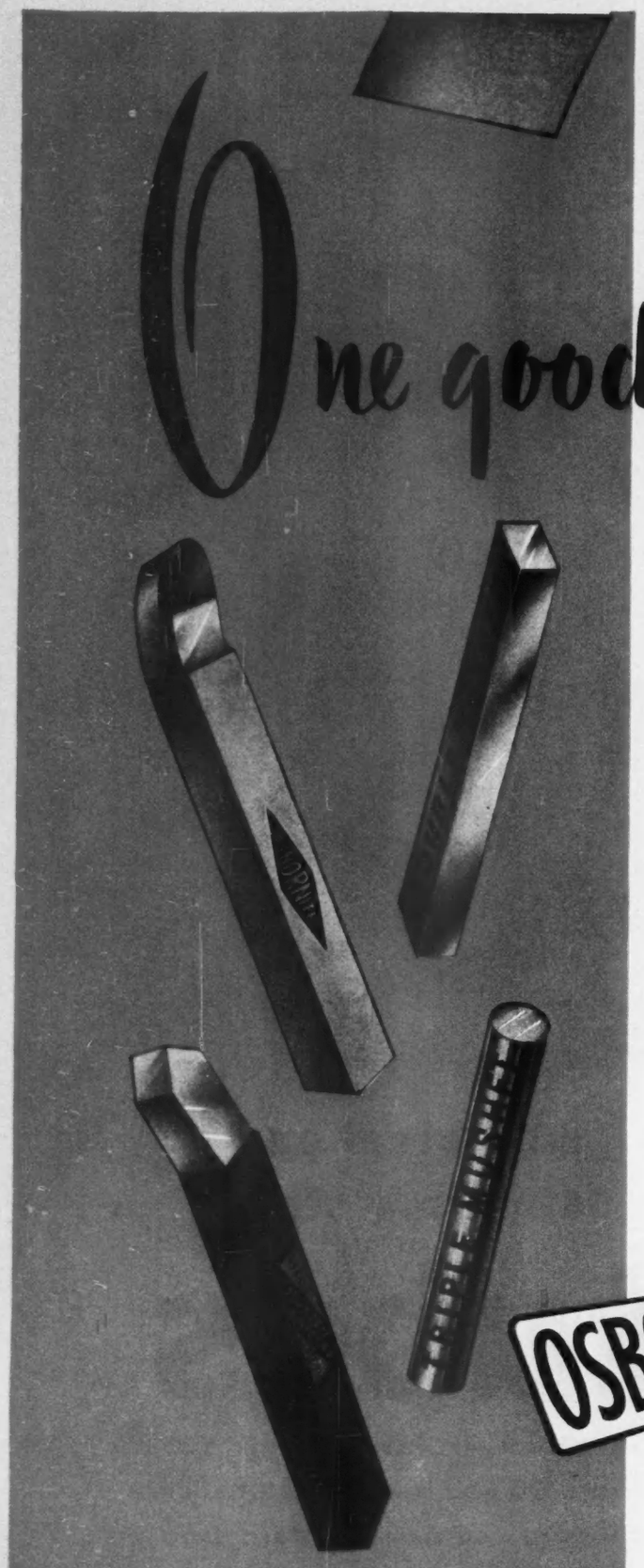

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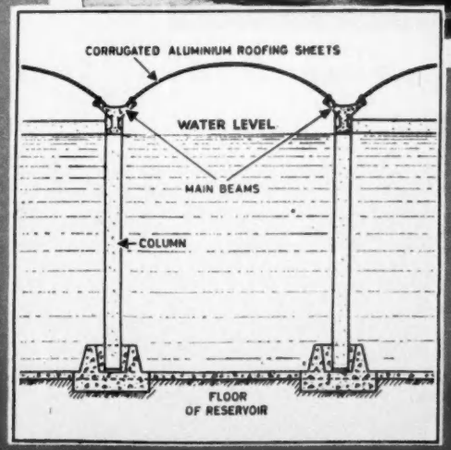

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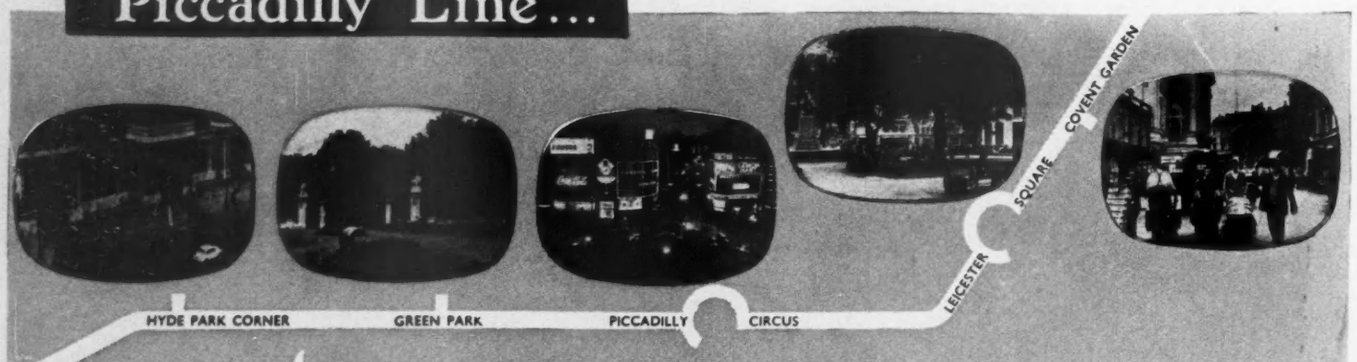

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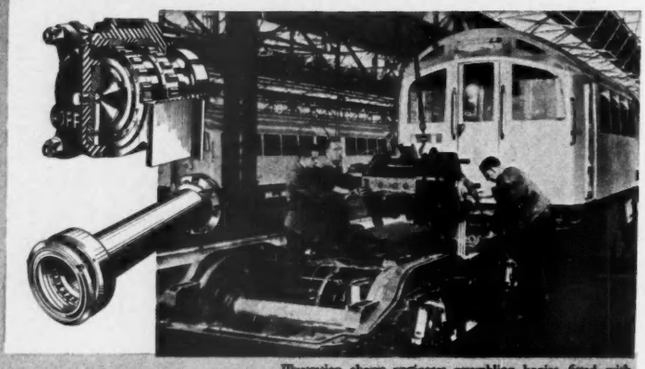

Illustration shows engineers assembling bogies fitted with Hoffmann equipment for the all-silver high capacity passenger coaches built by Metropolitan Cammell Carriage and Wagon Company Ltd., for the Piccadilly Line.

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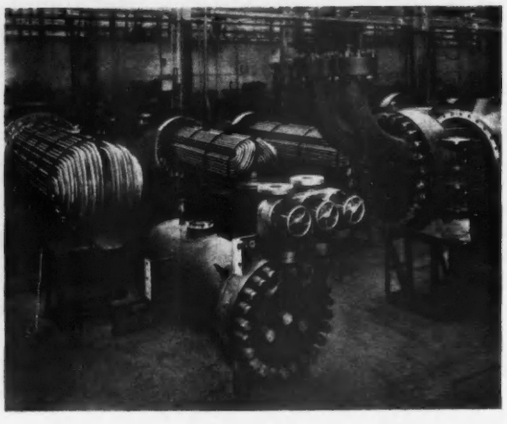

H & W solid drawn copper tubes used in construction of Weir Marine Feed Water Heaters. (Photograph by courtesy of Messrs. G. & J. Weir Limited.)

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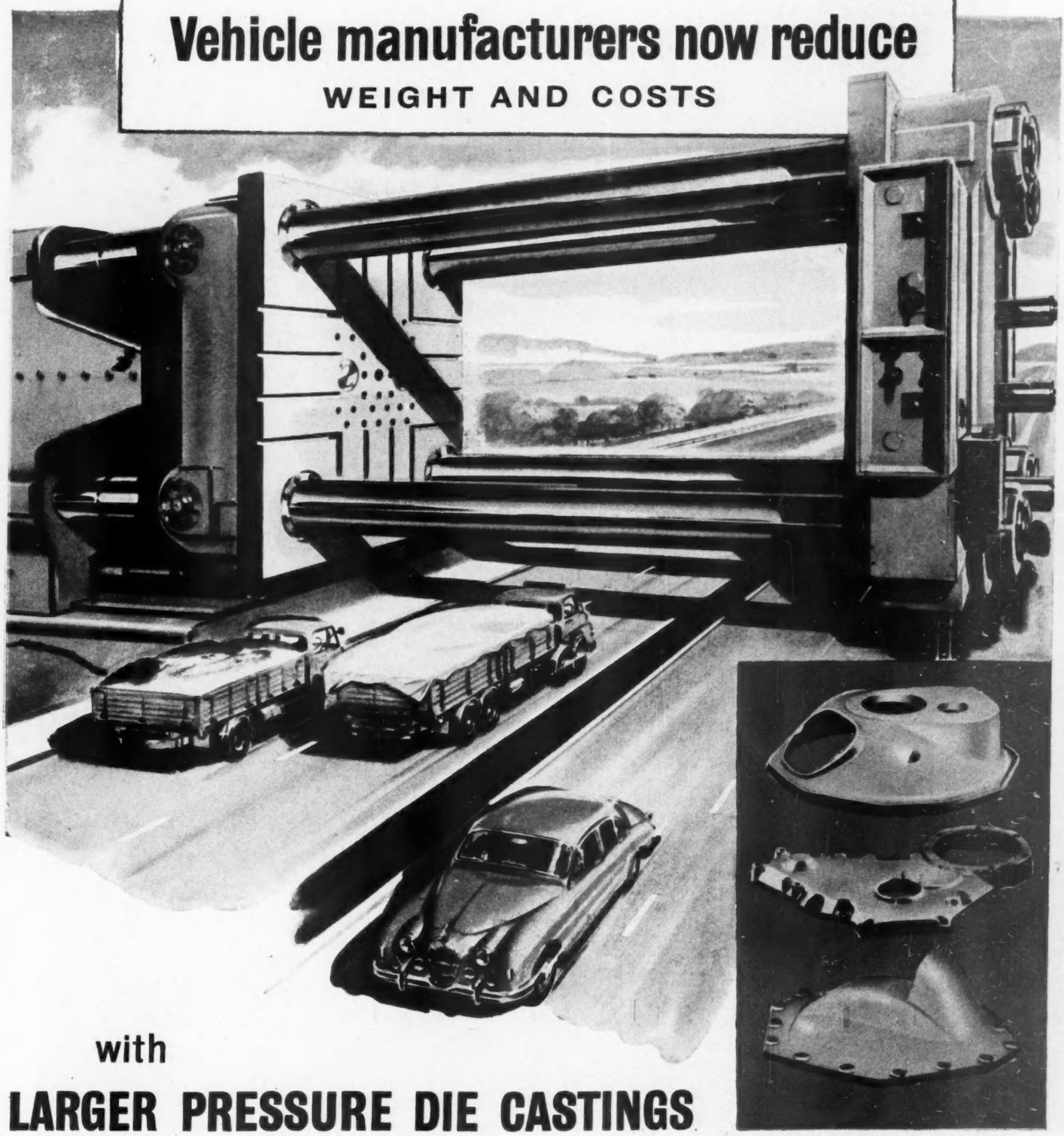

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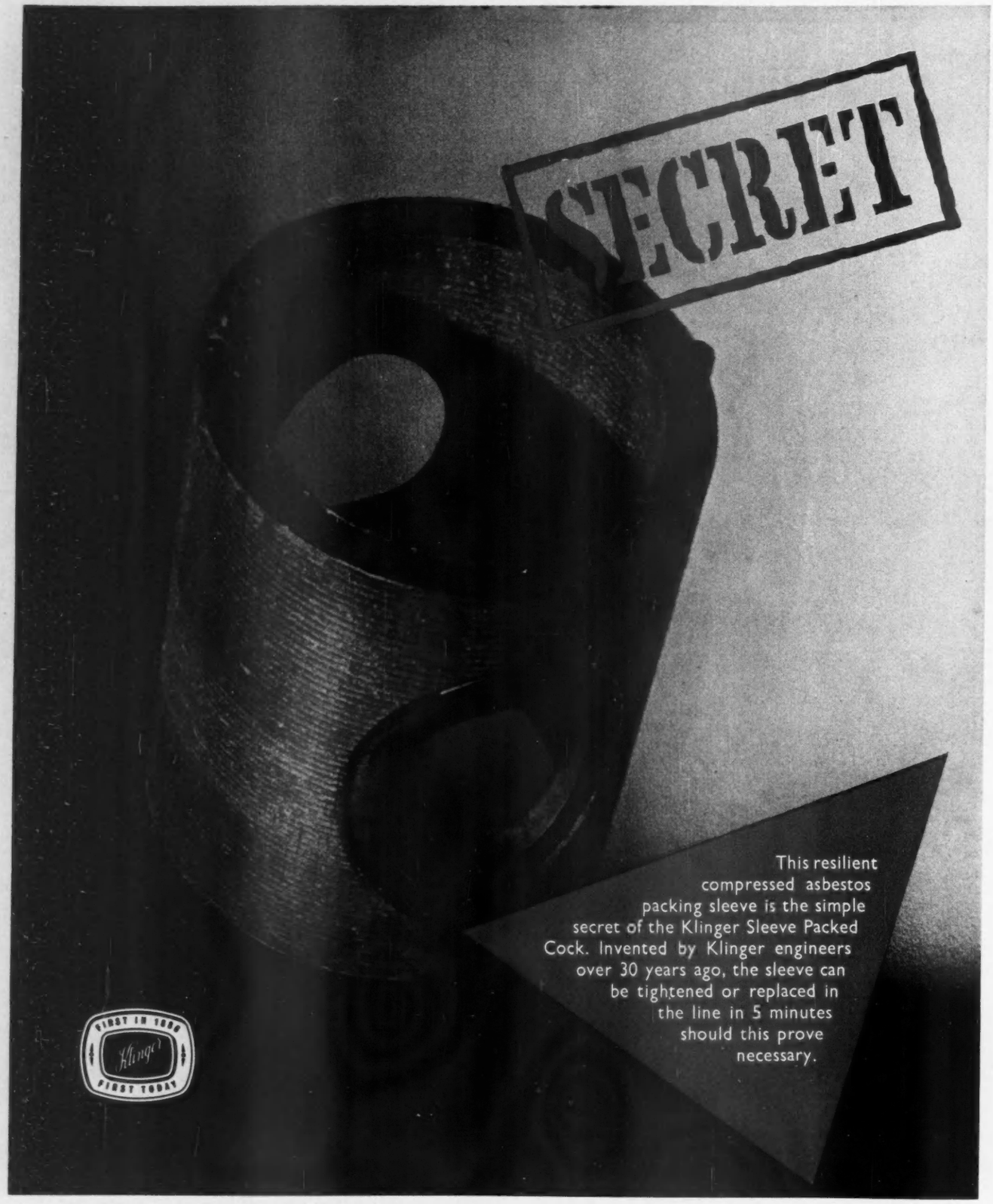
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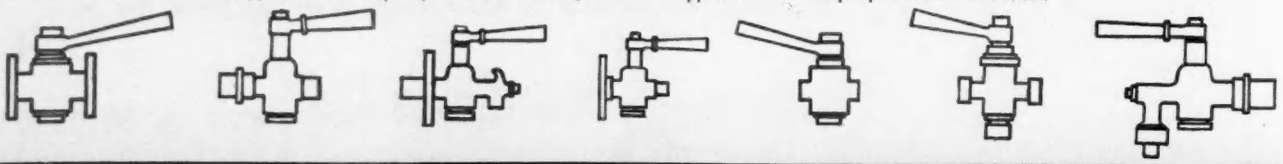

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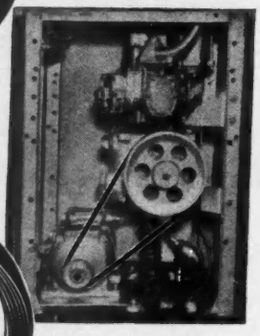

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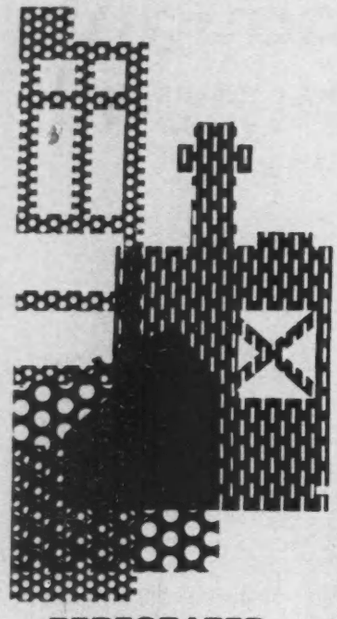

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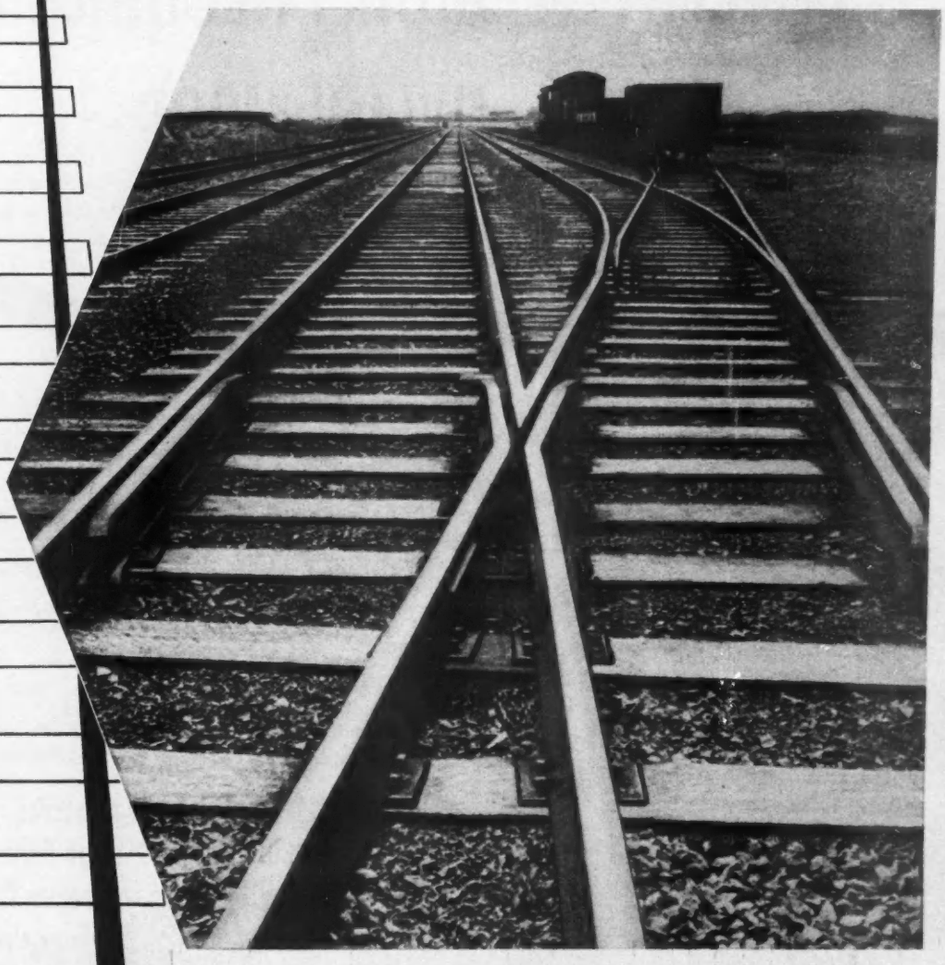

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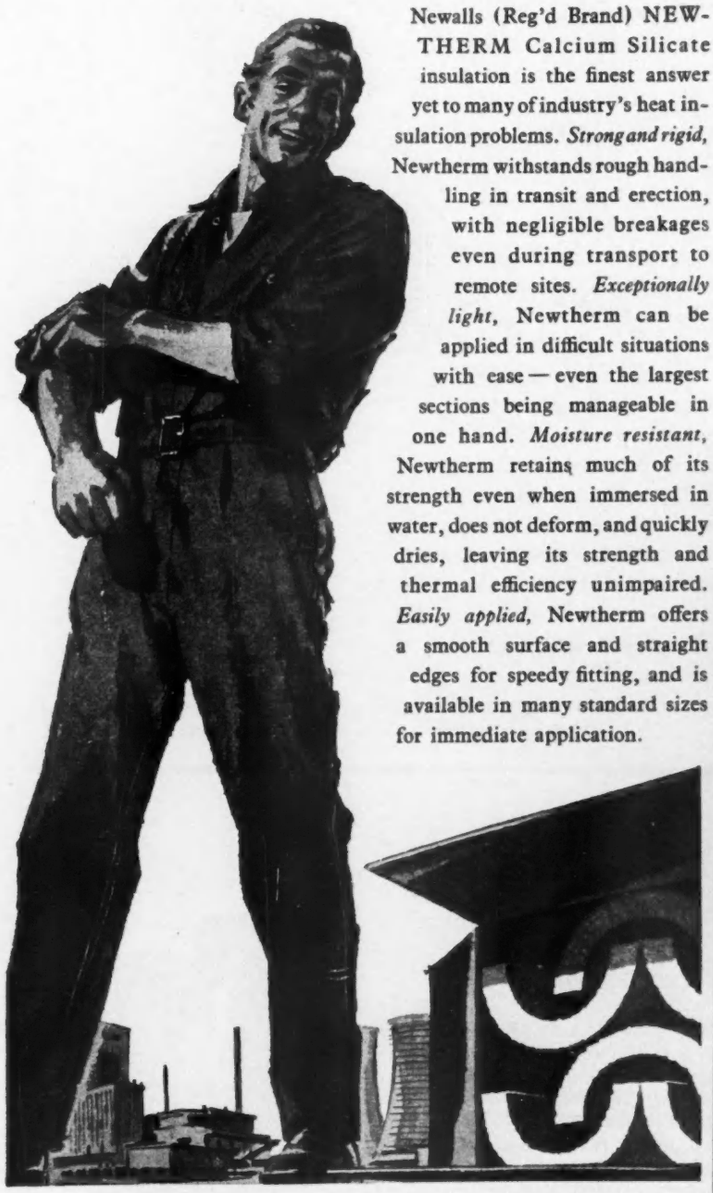

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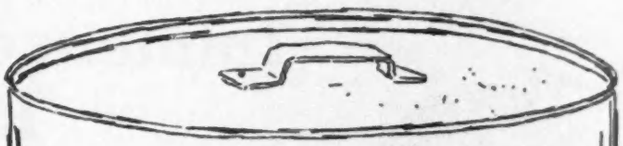

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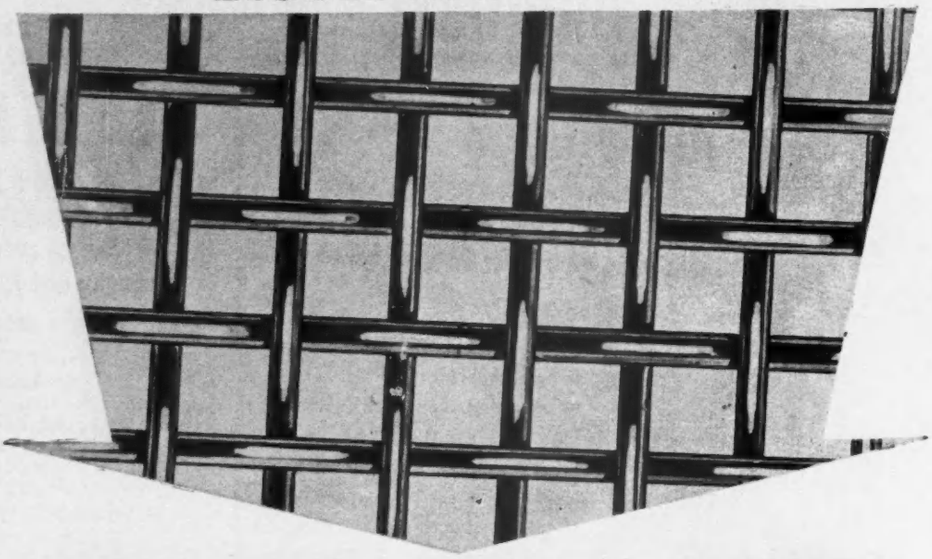
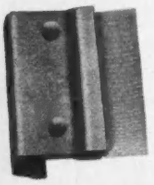
Resistant to abrasion



VIBRATORY SCREEN MESHES
including special
"AGATE" and "AGATEX"

These are suitable for all particle sizes.



The MC50 Galvanised Steel Clip developed specially for tensioning of vibrating screen cloths.

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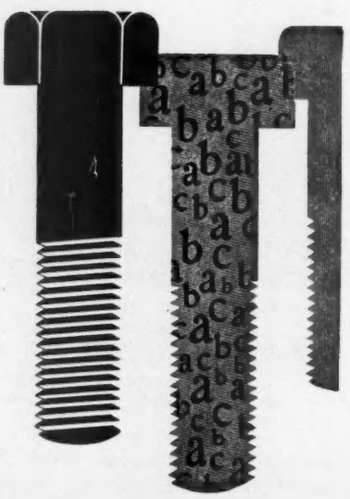

*ALUMINIUM BRONZE has virtues aplenty—and few, strictly measurable vices—as a material for nuts, bolts and setscrews on chemical plant, railway signals, electrical pylons and in other exposed applications.

Where sea water or polluted fresh water abound—near dockside cranes, in washing machines or laundry equipment, A.B. will not submit to these insidious corrosives.* Immune from de-zincification, unperturbed by temperatures in the 300-400°C range, A.B. has a tensile strength of 45-55 tons.

Specification? D.T.D. 197A. Standardisation? B.S. 2033. Application? You name it.

**For nitric acid and other oxydizing acids we recommend (and manufacture) Stainless Steel.*

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BOLT BUYERS. Trace supplies of bolts, nuts and setscrews quickly by having our Monthly Stock List on hand. Please send your name for inclusion in the monthly mailing list.

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WELL, WHAT IS IT?

(To be fair we should point out that the domed top and fabricated cantilever are part of a test rig. The thing in question begins at the weld below the lettering).

Unless you happened to see, in an earlier advertisement, the cardboard model in which the idea took shape, memory will be no help. This is something quite new.

It is an expansion joint, one of 72 such joints that will take up the expansion of the CO_2 ducting at the Trawsfynydd Atomic Power Station. Internal pressure 265 p.s.i., temperature 420°C. The convoluted bellows holds the internal pressure; the end thrust—over 1,000,000 lb.—is taken by the inclined, high-tensile steel bars round the periphery; flexing is entirely by elastic straining of these bars. The illustration shows the joint being prepared for the Insuring Authority's acceptance test—1,250 full deflections under full internal pressure and temperature. Compared with previous joints for this kind of work it is lighter, simpler, cheaper. It is the kind of highly original solution to both new and old problems that Richardsons Westgarth engineers can, and frequently do, produce.

RICHARDSONS, WESTGARTH & CO. LTD.

The Controlling Company of The Richardsons Westgarth Group,
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FLUES & FLUE-PIPE LININGS
KILN CAR & BOGIE TOPS
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APCI

ENGINEERING Impact

of Long-Term Trends for Capital Goods Producers

NEITHER the short time being worked in all but one of the car firms nor the bustling business of the Midland shopping centres is more than a partial guide to what is happening, and will happen in the future, in the main industrial centres.

For the motor industry there is little expectation of a swift return to the output levels of a few months ago, or to the high sales of the American market in its pre-Compact days. The belief in some quarters that the rising consumer standards of Western Europe would offer British cars effective opportunities to replace their former outlets across the Atlantic has suffered a serious setback. The blow came with the opening of the Turin motor show.

The British Motor Corporation was able to claim very recently that its smaller models being assembled in Italy by Innocenti, the large industrial concern perhaps best known for its scooters, would be priced well below anything comparable being sold in the country. But an answer has very quickly been given by Fiat.

At the Turin opening it was discovered that in one swift cut the wide price margin that should have substantially helped BMC-Innocenti sales had been reduced to one of £5 before the sales battle had been joined.

The implication is that the going in Europe is going to be hard. If the British car firms should have to look to other sales territories than the United States and Europe then the problem of keeping the vastly expanded capacities of the next few years fully occupied is going to be particularly hard. Not only are these two areas the most important motoring markets in the world, the remaining nations, South Africa, those in the Far East and South America will be increasingly served by the growing export efforts of motor manufacturers whose lines of communication are very much shorter than those from Britain.

Labour Still Short

But if the future for the car industry is tortuous there are other Midland industries whose order books are growing. Many of the companies producing heavy engineering equipment, constructional equipment, machine tools, commercial vehicles and other capital goods are not only working to lengthening delivery dates but are still faced with a shortage of skilled labour.

This is not a situation which is likely to be very much eased by the car companies being forced to place semi-skilled workers on short time. If the same thing happens to the component producers, with their higher proportion of skilled people, then the situation could change relatively swiftly, and to the advantage of the widely differing concerns in the engineering industries whose difficulties are not those of selling but of raising output to take advantage of the demand.

With output for the consumer market reduced in its most influential sections and the manufacturers of capital plant and equipment working at a great pace there is a lack of balance in the position that will not continue. But if there is a sufficiently swift recovery in sales of consumer appliances, and also if there is no strong tend towards rephasing the car factory development schemes over a longer period, then the capital goods producers could well go straight on from their present period of activity into another of at least the same intensity.

No Survival Without Profitability

One of the few organisations with a considerable body of information on the smaller private companies is the National Union of Manufacturers Advisory Service Limited. And from this knowledge the managing director of the Service, Mr. G. L. Page, has distilled the belief that many small firms will not survive unless they pay more attention to profitability.

The theme of the conference at which Mr. Page recently put forward his view was " Managing to Make a Profit." As he pointed out, there are indeed many, many conferences in the course of the year, and it is curious that the subject of profit receives only scant attention.

When the Advisory Service was set up, with the financial and moral support of the Board of Trade, to give independent and objective advice to the smaller companies, there was at first a tendency to be concerned with matters largely of productivity

Attracting Investors

Experience has brought about modification of this position. There had, for example, been a firm with an excellent technical reputation which had been compelled to sell out because although its turnover was mounting, losses were increasing due to rising costs and to what Mr. Page called " a quite unrealistic commercial policy."

If many smaller companies were short of capital this was not due to a lack of sources of money but because risk capital could not be attracted. The investor from outside would look for a return of 20 per cent on the total capital employed and of about 10 per cent on the turnover. At least nine out of ten companies smaller fell short of these returns.

Since about 40 per cent of the labour force of Great Britain is employed in small firms it is obviously important that the companies employing them should be working as efficiently as possible.

Mark of Efficiency

And a good profit level is an indicator in the matter of efficiency for, in Mr. Page's words, an unsatisfactory profit rate induces a policy of make do and mend, of hanging on not only to outworn plant and machinery but to out of date management organisation. This is because neither plant nor better management can be afforded when the only thing that gets bigger, if not better, is the overdraft.

Imaginatively handled, the methods of modern management are all there to be picked up by any firm that has not done so and is intent on carving out a future for itself. It is not necessarily a gloomy situation to which Mr. Page has drawn attention, but it is certainly one of great industrial significance.

of Repeated Heavy Losses From Industrial Fires

The record of major fires in recent months, and the three principal fires of last year which caused losses of more than £7½ million in engineering, motor and aircraft factories, indicated that even though the outbreaks can be put down to accident, there is substantial need for better means of preventing the start of fires, or at least of preventing their spreading.

It is the essential paradox of the situation that the same requirements for steady, uninterrupted production flow produce the conditions under which fires, once started, may spread and reach an intensity which keeps the firemen from doing more than direct their hoses on the blazing buildings from outside.

The autumn issue of the Fire Protection Association's *Fire Protection Bulletin* puts the issue well when it says that the factors which predispose managements towards open-plan factory floor space without division walls are fourfold. The advantages are the uninterrupted flow of conveyor lines, automatic transfer and other continuous flow devices; free movement of internal factory transport; unbroken view of floor space for supervision; and flexibility for alteration of layout.

These are needs which the north-light roof structures with prefabricated supports are very well suited. Given a well bituminised corrugated steel sheet roof and a soft fibreboard thermal insulation this leads to a position where fires have been able to spread without being seen and where smoke and heat have been produced in a degree that makes the fire fighters' job very much more difficult. There has also been the repeated case where the roof supports have collapsed making the job of controlling the fire worse and increasing the losses.

If a management wants to stick to this factory plan then the most efficient way of attacking its disadvantages is to use an automatic sprinkler system. Their natural advantage is that of arresting the outbreak as soon as it is warmed up enough to bring the system into play.

The Fire Protection Association recommends that even where there is a sprinkler system, there should be fire separating walls dividing the factory into the smallest practicable areas.

US Machine Tools in Europe

One of the features of the Hanover Machine Tool Fair was the increased number of foreign exhibits at what was officially called a " national exhibition." One of the most striking aspects of this invasion is the growing influence of American companies in the European market.

In terms of world production of machine tools the United States leads with 23 per cent, followed by the USSR with 18 per cent and Germany 16 per cent. In export performance the order is very different. Germany with 38 per cent of world total exports comes first, followed by the United States 24 per cent, Switzerland 12 per cent and Britain 11 per cent. Nevertheless German machine tool makers have been increasingly concerned at the efforts made by American companies to build up sales and production capacity in Western Europe, not only inside the six nation European Common Market but in the European Free Trade Association (the Seven) as well. One of the factors prompting this development is the desire to take advantage of lower labour and raw material costs.

Many American firms have concluded licensing agreements with British and West German concerns. All told more than 70 American machine tool companies are estimated to have started operations of one kind or another outside the United States. At the present time the German machine tool manufacturers are watching developments without getting too worried at the increased competition implied by this new development.

They advance three reasons against undue alarm. The first is that automation, where the greatest demand is to be expected, is no longer limited to mass production techniques, but is being increasingly applied to individual manufacturing processes. Secondly, ability to give firm delivery dates is regarded as at least as important as quality and price. Thirdly, even working at full capacity the German machine tool industry is unable to meet domestic demand.

In short the market is big enough at present for everybody, the efficient firms are still sure of success. But the smaller and less well organised concerns may be feeling the draught before very long

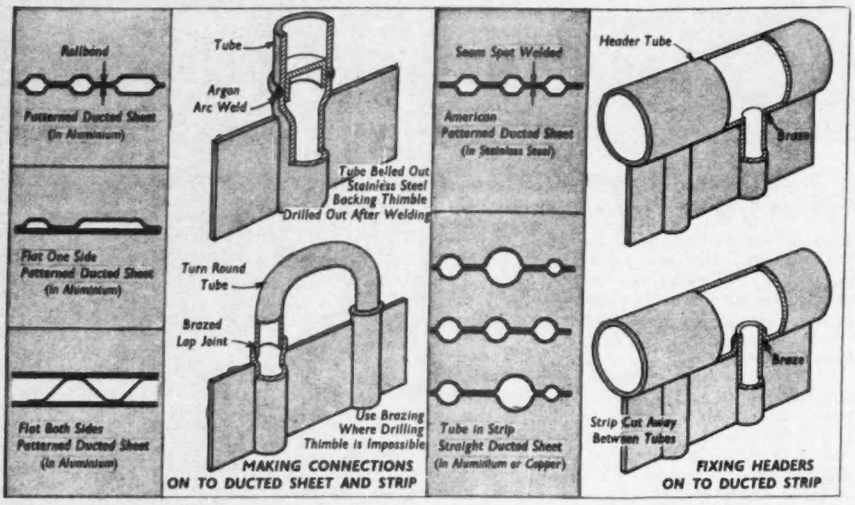
and Cheap Feedstocks in Wales

By locating their new refinery at Milford Haven, Esso Petroleum have cut the capital cost of building and they will have reduced the cost of bringing the crude oil to the refinery because the deep water of the Haven will allow them to use the largest tankers available—they have three 75,000 ton vessels building. Add these economic advantages to the experience of operating Fawley for several years and there is good reason to accept Esso's claim that they will be able to produce fuels and petro-chemical feedstocks cheaper at their refinery gates than most other suppliers.

The refinery—described as the most automated in Europe—now covers 350 acres out of the 1,100 that the company have bought and the crude oil capacity of the plant erected so far is around 4½ million tons per annum—sufficient on present plans until 1965-6. But there is room within the existing plant to expand the production of feedstocks, such as virgin naphthas and aromatics generally, if the buyers will take them. Esso can produce these basic materials for the plastics industry—who is going to buy? Land is cheap in South West Wales and there is labour to be had there. (Of the 350 permanent staff required to run the refinery only 45 were imported from Fawley, the rest are local people who have been trained in a matter of months so that only 25 are required during each shift to keep the plant operating.) A fast road to the area could be the catalyst required to start a new plastics industry in Pembrokeshire.

Strip Heat Exchangers in Three Metals

Sheet metal with ducts in it offers exciting prospects for redesigning heat exchangers. It is now being made in aluminium and copper in the UK and stainless steel in the USA.


Railbind
Patterned Ducted Sheet (In Aluminium)
Flat One Side Patterned Ducted Sheet (In Aluminium)
Flat Both Sides Patterned Ducted Sheet (In Aluminium)
Tube
Argon Arc Weld
Tube Belled Out
Stainless Steel Backing Thimble Drilled Out After Welding
Turn Round Tube
Brazed Lap Joint
Use Brazing Where Drilling Thimble is Impossible
MAKING CONNECTIONS ON TO DUCTED SHEET AND STRIP
Seam Spot Welded
American Patterned Ducted Sheet (In Stainless Steel)
Tube in Strip Straight Ducted Sheet (In Aluminium or Copper)
Header Tube
Braze
Braze
Strip Cut Away Between Tubes
FIXING HEADERS ON TO DUCTED STRIP

MANY pretty pictures have been published showing evaporator units used in most domestic refrigerators—made from aluminium sheet with ducts integrally formed in it. But it would be a pity if this introduction to the materials did no more than whet the imagination of engineers on how else to exploit these ducted heat exchanger materials. This is even more true now that similar products are made in a range of metals including aluminium, copper and their alloys, and stainless steel.

Absence of what most of us would consider large-scale heat exchanger applications illustrates just how little they have been accepted in the five years of their existence as commercial products. The aim of this article, however, is not to highlight the makers' sales problems but to help you understand these materials; for the main thing to realise straight away is that if the extra cost of these materials is going to be turned into profit, then articles should be redesigned. Far from being a disadvantage, this necessity is an attractive feature of ducted sheet and strip, because products made therefrom can have a sleek appearance coupled with very sound technical properties.

There are three methods of making ducted sheet and strip, and apart from new concepts of, say, replacing tube bundles, they all most obviously compete with the traditional tube-brazed-on-sheet construction. For the aluminium product the basic price of sheets with patterned ducts is around 7*s* 6*d* a lb, and is 5*s* for the variety in which the ducts are straight and parallel to one another. In other words, for the convenience of avoiding brazing operations and getting the new-look material, one must pay between 1*s* 6*d* and 4*s* a lb extra.

Cross-sections through passageways are shown in the illustration. These are made by three processes which feature different ways of bonding the metal on each side of the "tube." An understanding of bonding is the key to understanding what you can expect in design, so here is a quick summary.

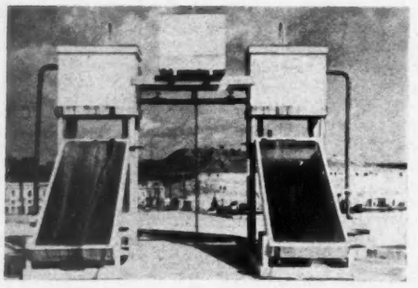
If one thinks of these materials as sandwiches of two sheets, then the bond can be obtained in one way by roll welding the sheets together with a stopping-off material printed in the pattern of the final ducts; after inflation this yields what Impalco call roll welded sheet and what Alcan Industries call Noralduct, and allows patterned ducts of varying shapes and dimensions to be made. Normally, hydraulic inflation is performed between platens, so tube surfaces are flat. A variation on this, which is the second process and successfully used by Tranter Manufacturing company in the USA, is of actually spot welding or seam spot welding the sheets together; Tranter perform this operation on stainless steel and a variety of metals which can be spot welded.

To keep the cost down, the distance between adjacent tubes is best kept to the width of a weld button. As with ducted aluminium, any pattern can be produced. This process differs from the other two in that ducts are made by pressing before welding rather than inflation after welding. APV make a simplified version in the UK with straight ducts but do not tackle patterns. The next and last process is the cheapest but yields only straight, parallel ducts; the bond here is not really a bond at all in that the sheet is rolled down from *one* ingot which incorporates rods of stopping-off material when it is cast. ICI and Impalco call this Tube-in-Strip and make it in copper, and aluminium and its alloys, respectively. When inflated—and the companies recommend that you do it yourself—the ducts are truly circular except for a small crack on either side, and can vary in spacing and diameter.

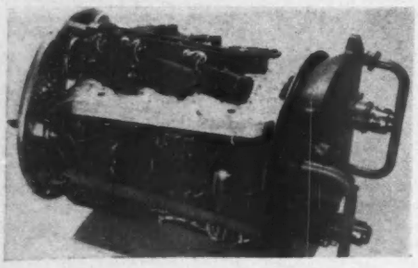
All bonds made in the above manners seem to be sound. Thus Impalco's ducts in aluminium of $\frac{3}{8}$ in width in 0·060 in web thickness will withstand 1,200 lb per sq. in before bursting at room temperature, and the figure quoted by Alcan Industries is identical. Impalco's Tube-in-Strip with a $\frac{3}{8}$ in tube in 0·050 in thick aluminium will burst at 1,680 lb per sq. in; and in deoxidised copper, ICI's product with 0·055 in webs will burst at 4,400 lb per sq. in at room temperature. Tranter say their stainless ducted sheet will withstand steam at 250 lb per sq. in—which means at temperatures above 205° C—with a safety factor of 5 on this pressure.

Know-how is needed with all these materials in making connections. Marston Excelsior's recommendations for Tube-in-Strip are shown above (centre); the ideas are basically similar for pattern-ducted sheet except that the braze or argon-arc weld is more substantial and normally takes in some of the web. Copper to aluminium junctions are made by flash butt welding and covering with plastic tube to stop corrosion. Note that where more than one tube is being fitted into a header, you can rely on the spacing of tubes in ducted sheet being exactly where they were printed, but for Tube-in-Strip, the web tolerance on width is plus or minus $\frac{1}{16}$ in for copper and similar for aluminium. It is for this reason that Marston's, who have used "quite large quantities of aluminium Tube-in-Strip . . . in manufacture of evaporators, coolers, heat exchangers and the like" recommend treating each duct separately.

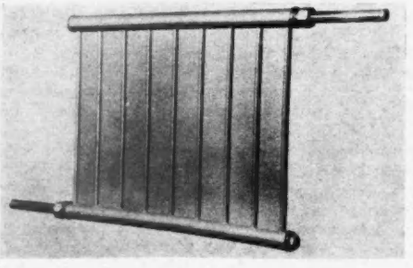
One last point concerns quantities and costs. Tooling for pattern-ducted aluminium is quoted by Alcan Industries as £25 for the silk screen needed to print on the stop-off, so this process is of most use in large scale production. Tube-in-Strip can be bought from stock in standard configurations and is suitable for one-off work. Ducted stainless steel is in a higher price bracket but can be obtained in the USA in several standard panel designs.



***Solar Heaters.**—Characteristic of one large surface recommends Tube-in-Strip for solar heat collectors. This one was installed in Malta. On the same principle, one has recently been installed for heating an outdoor swimming pool in the South of England.*



***"Electronics" Cooling.**—Chassis of this equipment for aircraft will be cooled through fluid in the ducts. The Royal Radar Establishment developed this and used Impalco aluminium sheet. Copper Tube-in-Strip made by ICI has successfully been used by people such as McMichael Radio for support and cooling members for other electronic equipment.*



***Domestic Radiators.**—There is a large market for Tube-in-Strip in radiators. This one is in copper, made by A. Benn and Sons from one length of sheet brazed on to a header tube. For skirting board heating with electrical elements, the aluminium product is admirable.*

Plans for More Aerated Concrete

Work has started on the construction by John Laing and Son of a new factory for their associated company Thermalite Ytong at Agecroft, Manchester, for the mass production of high pressure steam cured aerated concrete. With this and other planned factories, the company's nett productive capacity will be five times that of 1958.

An important constituent of Thermalite, which is manufactured in the form of lightweight load-bearing insulating building blocks and reinforced slab units, is pulverised fuel ash, formerly a waste product of solid fuel fired power stations. With a dry density of 50 lb per cu ft, the finished product is less than half the weight of brickwork and only 60 per cent the weight of clinker concrete, while having excellent workability and fire resisting qualities.

Thermalite Ytong Limited, 4 Regent Street, London, SW1.

Getting to Know Viton Rubber

Compounders and moulders of special purpose rubbers are quickly getting to know how to handle the high temperature resistant rubbers made by Du Pont under the name Viton. Thus Fireproof Tanks, Precision Rubbers and Ronald Trist have all made advances in formulation in the last year since the improved Viton B was launched. Fireproof Tanks are now able to make mouldings up to 18 lb in weight in shapes which would be considered difficult in any type of elastomer.

Ronald Trist offer the following comments as background. "Heat resistance is second only to that of silicone rubber and published data suggests that service life in the region of 1,000 hr at 230° C or 2,500 hr at 200° C may be expected. These figures relate to exposure to hot air. In fluids or gases the life may be reduced or extended according to the effects of the medium."

These outstanding properties of Viton stem from its chemical similarity to ptfe which, of course, is unique among flexible materials so far as extreme chemical and heat resistance is concerned. Unlike ptfe, however, Viton is a truly rubber-like material and consequently its field of usefulness is extended to those many applications where resilience or reversible deformation is required.

The rate of gas permeation through Viton is very low and similar to that of butyl rubber. The following relative values of permeability to carbon dioxide explain the use of Viton in seals for hot carbon dioxide in atomic projects: silicone rubbers—200 to 500; neoprene—100; butyl—5; Viton—6.

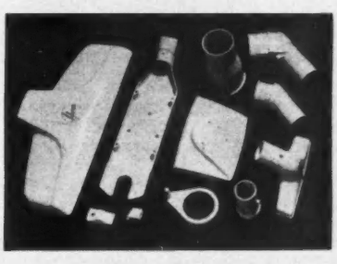
Precision Rubbers take up the commentary: "Viton compounds continue to find new applications where resistance to fuels, oils and greases combined with high temperature is required." The rubber is excellent for steam applications, and for this the company have developed special grades. But for dry heat, Precision Rubbers currently think that silicone rubbers are better, this observation being based on observations of hardness and volume changes occurring in Viton and silicone compounds after periods up to 63 days at 200° C. Thus the volume increase with the best silicone is a maximum of 2·2 per cent reached after 42 days, compared with the figure for Viton of 2·8 per cent in 14 days. The same compounds show hardness increases of 7 in 63 days with silicone and 14 days with Viton which once again points to the supremacy of this Precision Rubbers silicone mix compared with their Viton one.

Now what about the new silicone hydraulic fluid called DP47 marketed by ICI as a wide temperature range (−65 to 400° F) hydraulic fluid? Like Skydrol fluids (the di-ester-based non-flammable fluids developed by Monsanto), this chemical poses problems in choice of rubbers for seals. Resistance to Skydrols was obtained by modifying butyl rubbers, but it seems that Viton will be the answer for the silicone fluids. Certainly this view is held by Fireproof Tanks who have found that their composite aluminium and Viton gasketing material (one of their Hyclad range) will happily replace Dowty seals in contact with these fluids. Precision Rubbers comment that DP47 has presented rubber technologists with the problem of finding a rubber that will not shrink and harden when in contact with this fluid at elevated temperatures. Viton has the advantage of higher strength, low swelling in oils and fuels and somewhat lower compression set. But once again the silicone rubbers are quite at home with the silicone fluid, and as well as having superior low temperature properties, they swell in DP47 rather than shrink. Rather than attempt to mix the rubbers, Precision Rubbers point out that US engineers have compromised by mixing the fluids in contact with rubbers. If similar decisions are taken in the UK, it looks as though Monsanto's Skydrols will not be thrown overboard in favour of the silicone fluids, and in finding rubbers to contain the hydraulic fluid, Viton will certainly play an important part.

Fireproof Tanks Limited, The Airport, Portsmouth.
Ronald Trist and Company Limited, Slough, Bucks.
Presicison Rubbers Limited, Bagworth, Leics.

Polystyrene Replaces Metal

It was polystyrene which gave plastics a bad name when the domestic market was flooded with beakers and toys which promptly broke in the 1940's. But 40,000 tons of the same material were sold in the UK in 1959 (compared with 130,000 of pvc and 85,000 of polyethylene), and improved high impact versions which now form about 40 per cent of the market for polystyrene have done much to restore people's



confidence in the plastics family. You'll find them particularly in household equipment, and if you buy the latest Hoover vacuum cleaners, polystyrene mouldings which replace metal will be only too obvious.

Some seven different Hoover cleaners are now fitted with high impact polystyrene furniture nozzles, nozzle connector tubes, converter housings and other items, where strength combined with lightness in weight is essential. The version made by British Resin Products, Styron, (as with other makes) can readily be moulded into intricate shapes. In addition, as this material is self-coloured, no finishing processes are involved as with metal, and there is no fear of rust.

British Resin Products Limited, Devonshire House, Piccadilly, London, W1.

Small Indium-Bismuth Mercury "Batteries"

At Farnborough this year, Metachemical Processes aroused a great deal of interest by showing their small electrical cells based on indium-bismuth in place of the conventional zinc anodes. They are being developed to give a primary cell which is stable at high temperatures, has long storage life at normal temperatures, and gives a discharge characteristic which is substantially flat at both high and low rates of discharge.

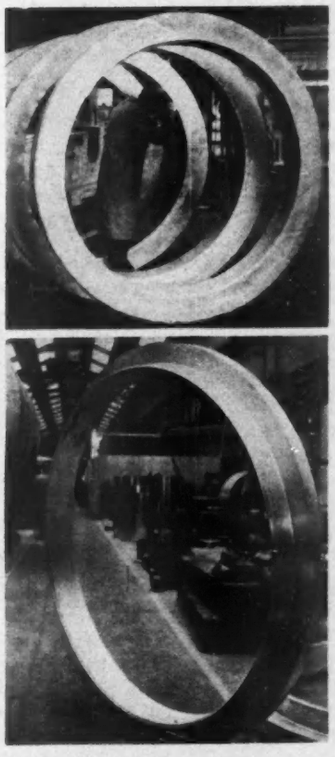
Development has reached the stage where cells with the following characteristics can be made.

Type 111 Cells—Low Drain	
Volume	0·35 cu. in
Weight	0·42 oz
Discharge rates	20-150 mA
Capacity	3 Watt-hours per cu. in at 20 mA discharge rate
Type 112 Cells—High Drain	
Volume	0·17 cu. in
Weight	0·2 oz
Discharge rate	400 mA
Type 113 Cells—Medium Drain	
Volume	0·35 cu. in
Weight	0·42 oz
Discharge rates	30-300 mA

Metachemical Processes Limited, Gatwick Road, Crawley, Sussex.

Aluminium Rings for Nuclear Reactors

Work has recently been completed on forging of four aluminium alloy rings which will eventually form part of nuclear reactors. These are believed to be the largest forged aluminium rings ever produced in this country, each unmachined ring weighing about 1,300 lb, with an outside diameter of 76 in, an inside diameter of 61¾ in,



and a thickness of 8¼ in. The rings were forged for the APV Company in Noral 54S aluminium alloy at the Handsworth, Birmingham, works of Alcan Industries (formerly Northern Aluminium).

Each ring was formed from a cast rectangular shaped blank which was pierced to receive a mandrel and was then subjected to several ringing and flattening operations, using progressively larger mandrels until the finished forging of over 6 ft outside diameter was obtained. The ringing operations were performed on a 1,200 ton hydraulic press and the flattening operations on a 4,000 ton hydraulic press. The finished forging gave a machining allowance of ¼ in on all dimensions, and this machining was carried out by the APV Company. The illustrations show the rings after completion of forging and after initia machining.

Alcan Industries Limited, Banbury, Oxon.

Plain Words

By Capricorn

TWICE lately I have attended dinners where the principal speakers have dwelt long and ruefully on the status of engineers. Excellent food and wine, good company, and brilliant speakers—but with a tendency to harp. Why should engineers all of a sudden be so concerned with honour and professional prestige? Perhaps we do protest too much.

Engineers were never gentlepeople. The earliest references showed the engineer to be an uncouth fellow, outcast, humourless, the butt of popular derision, and certainly no gentleman. By bringing explosives and other devilish engines on to the battlefield he debased the art of war and took the chiv out of chivalry, a particularly distasteful innovation. Nothing more delighted the yeomanry than to see him in a mess of his own making: " For 'tis the sport to have the engineer hoist with his own petar."

As late as 1747 the engineer was classed as a tradesman, a practical man; so it smacks a bit of special pleading to complain when people nowadays confuse him with craftsmen of the AEU. Chartered engineers can only distinguish themselves from their fellow workers in the engineering industries by their achievements and their demeanour, not by aspiration and declaration. If they are to be worthy of professional standing, then it can only be in the manner of the American who professed to be " Scotch by absorption."

People who are touchy about their status only demonstrate the weakness of their convictions. It is those who most insistently affirm their manhood or racial origins who are often most in doubt—or care too much about it. The doctors only started losing face when the British Medical Association began kicking up a fuss. Top entertainers, like Sellers and Hancock, don't make a song and dance about being in show business.

The distinguished are unconscious of their distinction as the gentle are unaware of their gentility, or at least indifferent to it. I sometimes think the Bentley is the rich man's Rolls-Royce, for the truly rich do not need to make their riches manifest. Conspicuous consumption is only for the uncertain. That is why, contrary to popular belief, America seems to me a genuine patriarchy: the men are so confidently prepared to admit the influence of Momma. But engineers don't always seem too happy about being engineers. At a reunion I overheard one man excuse himself for failing to recognise a contemporary by saying that at college he had never mixed with other engineers.

Status seeking is the spanner in the works of our society; more than 30 per cent of human energy is wasted in its cause. Let us take our status for granted and get on with the job. And as with Solomon and Abou Ben Adhem, the rest will follow.

But in any case I always suspect that people who talk about raising my status are seeking an excuse to cut my wages. To hell with status, so long as the pay is good.

Letters to the Editor

Congestion and the Traffic Engineer

SIR, I have read Professor J. A. Proudlove's letter (ENGNG., 21 Oct.'60, p. 537) and looked at his winning entry in the competition organised by the Roads Campaign Council. Unfortunately I have not the time to make my own research into his paper.

Briefly, I argue that the centre of London will never be able to take the amount of road traffic that wants to come, that entry must be controlled by regulation and price mechanism, and that there is a tremendous field for development in all branches of public transport. Professor Proudlove answers that by restricting traffic the city centre will decay, and that all vehicles can be contained if we plan to construct elevated and depressed highways, underpasses, new ways, and generally realign our present routes.

It is often forgotten that London has an underground railway network, which, with the possible exception of Paris, is unequalled. Parts of the system, it is true, are running to capacity at times, but it does carry a great number of people who would otherwise use road transport. This should be exploited to the full and the possibility of additional tubes, some perhaps operating in parallel with existing workings, should be explored. The fulfilment of the Victoria line is eagerly awaited.

Freedom of movement for essential traffic we must have, but this should not be impossible to secure if the commuter can be persuaded that public transport is the cheapest and most comfortable way of coming to work. Then let us develop wisely, and within reasonable economic limits, without having to destroy our present alignments to create a concrete jungle.

Yours truly,
JOHN L. WALDRON,
Assistant Commissioner
(Traffic and Transport).

Metropolitan Police Office,
London, SW1.
3 November, 1960.

Translating by Computer

SIR, According to your article entitled " Russian Translated by Computer " (ENGNG., 1 April '60, p. 467), the Harvard University research team has not yet succeeded in computer translation of Russian into English. Although I do not doubt your source of information, this news surprises me.

In the second volume of the book *Mathematics: Its Field of Inquiry, Methods and Significance* (three volumes in the Russian language) published by the Academy of Science, Moscow, in 1956, there is given a sample of machine translation from English into Russian done by the high-speed electronic computer BESM of the above-mentioned academy. It is a very good translation. As a matter of fact I do not know how it could be improved. The book states that the first work on dictionary and programming for automatic translation was completed in 1955 and that the translation referred to was done at the end of that year. Further, it mentions the colossal volume of philological and mathematical work necessary to prepare a programme like this, and the fact that the BESM computer was not designed for this work.

The book quoted is intended mainly for the Soviet market, and its aim is to acquaint its reader with the history of mathematics and with this marvellous science as a whole (that is, with all mathematical subjects). Therefore, it is somewhat disturbing to read in 1960 that the Americans are still battling with the problem. It is only to be hoped that some other United States institution, such as the Bureau of Standards or some similar body, has been luckier, and has successfully tackled this problem some years ago.

Yours faithfully,
R. LUNIN.

Bankstown,
NSW, Australia.
2 November, 1960.

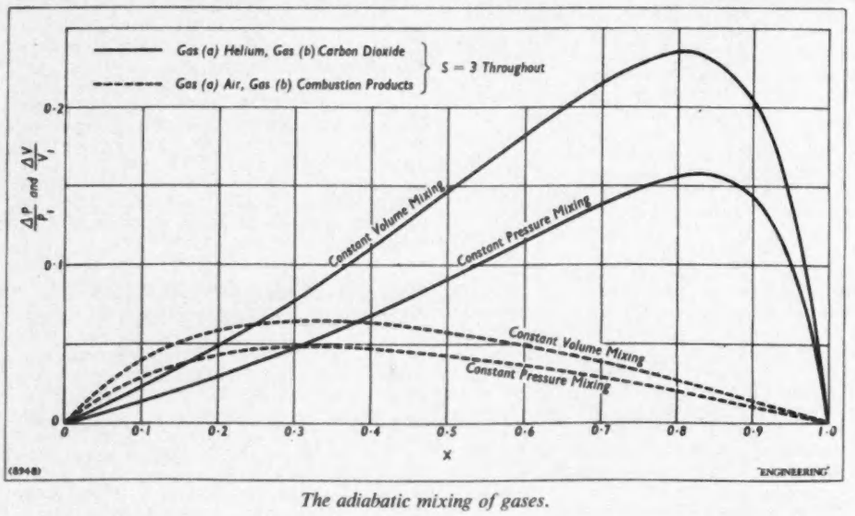
Mixing Gases

SIR, Following a previous letter, dealing with Dr. P. Chambadal's discussion of Gibbs' paradox (ENGNG., 7 Oct. '60, p. 468), I would like to draw attention to certain wider aspects of the general problem of the adiabatic mixing of perfect gases.

In a variety of practical circumstances, such as in power production, process work, etc., different gases may be introduced to one another; their initial pressures being equal, but their initial temperatures being markedly unequal. This last condition is outside the scope of Dr. Chambadal's discussion, and raises interesting possibilities which are not widely realised.

If the mixing be confined within a constant total volume, it is possible for the final pressure to differ from the initial common constituent pressure, P_1, by an appreciable amount ΔP. The extent of this effect depends: first, on the overall mass ratio; secondly, on the disparity between the initial temperatures of the constituents; and thirdly, on the disparity between the respective ratios of the specific heats of the constituents. It is as well to add that, under these conditions, the idea that there should be constant total enthalpy is false.

Alternatively, if the mixing should be governed by the condition that the mixture pressure should



The adiabatic mixing of gases.

always equal the initial common constituent pressure (constant pressure mixing), it is possible for the final total volume to differ from the initial total volume, V_1, again by an appreciable amount ΔV. The extent of this effect depends on the same three data as enumerated above.

These remarks are illustrated by the diagram reproduced here. The mixture of two gases (*a*) and (*b*), with an initial temperature ratio of $s = T_{b1}/T_{a1} = 3$, is displayed. The temperatures are in absolute measure. The mixture is conceived as made up of x lb of gas (*b*) and $(1 - x)$ lb of gas (*a*). The full lines relate to the case of gases (*a*) and (*b*) being helium and carbon dioxide, respectively; the dotted lines relate to the case of (*a*) and (*b*) being air and typical hydrocarbon combustion products, respectively.

These effects have obvious and definite repercussions on subsequent development of mechanical work. While by no means novel, and readily enough determined, they remain comparatively unfamiliar; and in the light of the present correspondence this is my reason for drawing attention to them.

Yours faithfully,
BORIS N. COLE,
Reader in Mechanical Engineering.

The University,
Birmingham 15.
28 October, 1960.

Transport by Canal

SIR, I was most interested to read your issue of 21 October, devoted almost exclusively to the disposal and use of waste products.

Although the problem of the cost of transport was mentioned, as I have become accustomed to expect, no reference was made to the great potential saving obtained by using our much-maligned canal system for this purpose. The only way in which canals are now used to any extent for the disposal of rubbish is without the intervening formality of a boat! Yet the carriage of scrap iron and steel is usually ideal for water transport; loading and unloading being performed by electromagnet, and the size and shape of the material being seldom unsuitable for narrow boats. In a trade whose stock costs practically nothing, the main expenses that the scrap dealer must pass on to his customer are those of storage, sorting and transport.

Though he may not know it (and a surprising number of people do not know what is behind the corrugated iron fence at the bottom of the yard) many scrap yards are waterside, or canalside land may be more cheaply obtained than most, and many foundries and mills are still occupying the sites used by the old iron masters, whose only transport facility was the "cut."

I frequently pass great lorries, cluttering up the roads in and around Birmingham and the Black Country, incongruously weighed down by two or three cubes of squashed swarf which could be transported far more economically by water or rail. There is, however, considerable prejudice in the country as a whole against canal transport, amounting in the motor industry (which above all needs the cheapest possible delivery of raw materials and removal of the finished product) to a blank refusal even to discuss the subject.

As you will recall, last year's meeting of the British Association revealed that 25 per cent of the gross national product is spent on transport. The present increase in road haulage rates of 10 per cent can thus be seen to represent an immense sum, of the order of £75 million.

This colossal burden, Sir, will be borne by you and me, in the form of increases in the general cost of living, simply because there is too much traffic on the roads, while we are also paying, through taxation, the enormous losses being made by the British Transport Commission just because they have too little.

Under their present leadership I think it unlikely that either railways or waterways will take full advantage of the situation; in fact, I understand that, because of a shortage of footplate men, British Railways are arranging with the National Coal Board to carry vast extra quantities of coal by road this winter.

As far as the waterways are concerned, the immediate formation of an Inland Waterways Conservancy, at present being urged upon the Government, and for the first time incorporating all the uses of water under one authority, would reduce canal tolls almost to nothing by charging realistically for water supplied to industry, land drainage, and fishing rights.

Surely it is time for the traditional British virtues of balance and common sense to overpower vested interests in transport?

Yours faithfully,
M. J. MACFARLANE,
Honorary Joint Secretary.

Midlands Branch,
Inland Waterways Association Limited,
Rugby.
24 October, 1960.

A Bridgehead for Trade

SIR, We have read with much interest your article entitled "Czechoslovakia: A Bridgehead for Trade?" (ENGNG., 30 Sept. '60, p. 438).

Sharing your opinion that a factory, in its role as the final user, can greatly influence the choice of the equipment to be imported, we find that direct technical explanation, and technical publicity in general, are most effective ways of promoting sales. Speaking of fairs, the prospective buyer should get as much information in advance as possible. This will enable him to arrange for the items he looks for to be included in his financial plan of purchases for the given period. In other words, contracts should be partially prepared before the Brno Fair opens.

It frequently takes a considerable time for the British manufacturer to succeed in gaining a foothold in the Czechoslovak market. West German competition, apart from its technical and commercial ability, has a more advantageous geographical position and, hence, more frequent visits are made across both sides of the frontier. It is noteworthy that the exports of Czechoslovak machine tools to West Germany are three times greater than those to the United Kingdom. The German language, too, is more common to the majority of Czechoslovak technicians.

Nevertheless, we feel that your observation that trade with the United Kingdom finds a favourable attitude is correct. This positon is, perhaps, not only due to the Czechoslovak authorities (although their desire for a distribution of imports and exports over a wider field is obvious), but also to the goodwill of British engineering firms and the belief of the Czechoslovak technicians in the "correctness" of their British partners. The technical reliability and lasting good performance of British engineering products play an equally important role.

The possibility of Czechoslovakia getting an opportunity to offer goods, and if competitive, to sell them, stimulates the placing of orders, perhaps more than does the current state of the sterling or Deutsche Mark accounts with the State Bank of Czechoslovakia. In fact, funds for the import of larger items are allocated well before a contract is finalised. So willingness to give Czechoslovak suppliers a fair chance to quote for orders, in line with other competition, is appreciated and possibly of more importance than just tough-linked barter deals which tend to become more and more outmoded.

The idea expressed in the heading of your article—"Czechoslovakia: A Bridgehead for Trade?"—I feel really "hits the nail on the head." It certainly expressed the essential outlook which an exhibitor at the International Brno Trade Fair should bear in mind. This is confirmed by the fact that our organisation has already been approached by one or two reputable British exporters who have outlined proposals of their own for next year's exhibition.

There is a scheme which has as its aim making greater use of the interest which the Brno Trade Fair has succeeded in arousing in the neighbouring countries of Romania, Hungary, the Soviet Union and Poland. The question of publishing in good time the technical details of what British manufacturers propose to exhibit at the Fair in 1961 seems also, in relation to these countries, to be of quite special importance.

The difference between the organisation of trade in Western and Socialist countries cannot be disputed. Consequently, the methods, means and channels of business are different, as well. Your article has undoubtedly brought much light upon this problem. Since it was written in an objective and correct way, with the aim of helping the development of East-West business, there is no doubt of its positive value. We, as specialists in Anglo-Czechoslovak trade, say so.

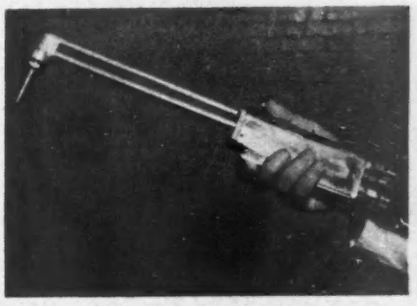
Yours sincerely,
J. SEIFERT,
Director.

Exico Limited,
London, SW1.
7 November, 1960.

Hard Facing in Thin Layers

SIR, We were interested to read your Research and Development article entitled "Powder Weld for Hard Facing" (ENGNG., 4 Nov. '60, p. 629).

The article describes a new method of hard facing in very thin layers which has been developed in Russia. The method described follows very closely the equipment designed and in use, manufactured by our company, called the model 50 powder weld equipment. The main difference between the equipments is that, with the F. W. Berk and Company's equipment, the powder is fed through the pistol under pressure and through a conveying gas, argon, thus eliminating the risk of oxidation. By using this method a very accurate and constant volume of



Berk powder weld gun.

powder can be fed through the oxy-acetylene flame and the equipment is readily adaptable to automatic hard facing technique.

The equipment is simple to operate and is twice as fast as arc welding, with a negligible powder loss and minimum distortion of the work. The spraying and fusing, of course, is carried out in one operation and the application is particularly suitable where a relatively thin overlay is required, as, for example, in thicknesses between $\frac{1}{32}$ in to $\frac{1}{16}$ in, and very good results can be obtained on thin base metal section of $\frac{1}{4}$ in or $\frac{3}{8}$ in.

An example of the Berk model 50 powder weld gun is shown in the accompanying illustration.

Yours faithfully,
R. K. FLETCHER,
Assistant Sales Manager.

Schori Division,
F. W. Berk and Company Limited,
London, NW10.
7 November, 1960.

Next Year's Industrial Finishes Exhibition

CONSIDERABLE interest has already been aroused by the announcement that the first International Industrial Finishes Exhibition is to be held at Earl's Court, London, SW5, from 8 to 11 May, 1961. The exhibition will cater for a wide range of finishes, including metal pretreatments, paints and their applications, electroplating, galvanising, metal colouring, anodising, plastic coverings, vitreous enamelling, shot blasting, vacuum deposition, marking processes and instrumentation. In addition, provision will be made for the exhibition of ancillary equipment.

Encouraged by the support which has been obtained so far, the organisers have decided to put in hand arrangements for the holding of an Industrial Finishes Convention to be held concurrently with the exhibition. It is proposed that this event shall also take place at Earl's Court and consist of two sessions daily. Suggestions for subjects and speakers are now being examined and it is hoped to issue a provisional programme at an early date. Preprints of the papers to be read are expected to be available to convention delegates prior to the opening date.

The organisers are the Exhibition Division of Scientific Surveys Limited, 97 Old Brompton Road, South Kensington, London, SW7 (Telephone: KNIghtsbridge 9360), from whom application forms and further information may be obtained.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Digital Computing Elements for Instructional Use," by Lieut.-Colonel I. W. Peck. Computer Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 16 Nov., 6.30 p.m.*

LIVERPOOL
"Design of High-Quality Sound-Reproducing Equipment," by R. T. Lakin, K. Davin and F. C. Gibson. Merseyside Section. Adelphi Hotel, Liverpool. Wed., 16 Nov., 7 p.m.

British Interplanetary Society and Institute of Navigation

LONDON
Symposium on "Navigation and the Early Exploration of the Moon." Joint Meeting. Royal Geographical Society, 1 Kensington Gore, South Kensington, SW7. Fri., 18 Nov., 10 a.m. and 2.15 p.m. (Tickets required.)

Combustion Engineering Association

PORTHCAWL
"Benson Boiler at Steel Company of Wales": Discussion. Seabank Hotel, Porthcawl, Glam. Thurs., 17 Nov., 10.15 a.m.

Diesel Engineers and Users Association

LONDON
"Practical Application of Torque Converters," by R. G. Hill. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 17 Nov., 2.30 p.m.

Illuminating Engineering Society

SHEFFIELD
"History of Lighting," by J. W. T. Walsh. Sheffield Centre. Grand Hotel, Sheffield. Mon., 14 Nov., 6.30 p.m.

Institute of Marine Engineers

BELFAST
"Closed-Circuit Feed Systems for Marine Installations," by T. O. Leith. Junior Lecture. Northern Ireland Panel. College of Technology, Belfast. Tues., 15 Nov., 7 p.m.*

CARDIFF
"Modern Marine Steam Turbines," by J. H. Gooch. South Wales Section. Welsh College of Advanced Technology, Cathays Park, Cardiff. Mon., 14 Nov., 7 p.m.

GLASGOW
"Medium Speed Diesel Engines for Marine Auxiliaries," by C. J. Hind. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 16 Nov., 7.30 p.m.

Institute of Metals

GLASGOW
"Cold Extrusion of Steel." H. L. D. Pugh. Scottish Local Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Mon., 14 Nov., 6.30 p.m.

SHEFFIELD
"Metal and the Architect," by A. Daykin. Sheffield Local Section. Applied Science Building, The University, St. George's Square, Sheffield. Thurs., 17 Nov., 7.30 p.m.

Institute of Road Transport Engineers

LONDON
"Fuel Developments," by L. P. F. Drake. Metropolitan Area. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 17 Nov., 6.30 p.m.

Institution of Civil Engineers

LONDON
"Recent Development in Nile Control," and "On an Analytical Study of the Storage Losses in the Nile Basin, with Special Reference to Aswan Dam Reservoir and the High Dam Reservoir (Sadd-el-Aali)," both by A. A. Ahmed. Tues., 15 Nov., 5.30 p.m.*
"Roundabout and Traffic Lights": informal discussion introduced by T. E. H. Williams and H. C. Smith. Traffic Engineering Study Group. Thurs., 17 Nov., 5.30 p.m.*

Institution of Electrical Engineers

BIRMINGHAM
"Some Considerations in the Application of Power Rectifiers and Converters," by J. P. McBreen. South Midland Supply and Utilisation Group. College of Technology, Gosta Green, Birmingham. Mon., 14 Nov., 6 p.m.*

BRADFORD
"Electricity in the Manufacture of Hydrogen Peroxide," by B. E. A. Vigers and R. O. Fletcher. North Midland Utilisation Group. Bradford Institute of Technology, Bradford. Tues., 15 Nov., 6.30 p.m.*

NEWCASTLE UPON TYNE
"The Transmission of News Film Over the Transatlantic Cable," by C. B. B. Wood and I. J. Shelley. North Eastern Measurement and Electronics Group. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Mon., 14 Nov., 6.15 p.m.*

Institution of Engineering Designers

BRADFORD
"Investment Casting for the Engineer," by N. Mason. Yorkshire Branch. Midland Hotel, Bradford. Wed., 16 Nov., 7.30 p.m.

Institution of Engineers-in-Charge

LONDON
"The Application of Transistors and Other Semiconductor Devices in Industry," by D. D. Jones and E. Jackets. Magnet House, Kingsway, WC2. Tues., 15 Nov., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

SHEFFIELD
"Feed Water Treatment," by W. F. Gerrard. Yorkshire Branch. Athol Hotel, Charles Street, Sheffield 1. Wed., 16 Nov., 7.30 p.m.

Institution of Locomotive Engineers

LONDON
"Refrigerated Transport on Railways," by T. A. Eames. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 15 Nov., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Adhesives Engineering": Discussion. Industrial Administration and Engineering Production Group. Mon., 14 Nov., 6 p.m.*
"Teaching of Metallurgy to Engineers," by Professor J. G. Ball. Meeting in conjunction with the Education Group. Wed., 16 Nov., 6 p.m.*

BIRMINGHAM
"Provision of Workable Substitutes for Missing or Defective Limbs," by D. S. McKenzie and Brigadier N. A. M. Swettenham. Midland Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. Thurs., 17 Nov., 6 p.m.*

DUNDEE
"Corrosion Fatigue," by Professor A. W. Scott. Scottish Branch. Technical College, Dundee. Fri., 18 Nov., 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
"Flotation Conditioning of Iron Ore with Petroleum Sulphonate," by Dr. Kun Li, R. W. Livingston and L. K. Lemke; and "Rehabilitation of Chang Hang Copper Smelter, South Korea," by G. J. Brittingham. Geological Society, Burlington House, Piccadilly, W1. Thurs., 17 Nov., 5 p.m.*

Institution of Plant Engineers

BLACKBURN
"The Automatic Control of Level in Boilers," by C. G. Scolding. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 17 Nov., 7.30 p.m.

DARTFORD
"Ball and Roller Bearings," by A. Hill. Kent Branch. Railway Hotel, Dartford. Wed., 16 Nov., 7 p.m.

Institution of Production Engineers

BIRMINGHAM
"Ceramic Tooling and Its Application to Metal-Cutting Machines," by R. N. Cook. Birmingham Section. James Watt Memorial Institute, Great Charles Street, Birmingham. Wed., 16 Nov., 7 p.m.

HALIFAX
"Tool Wear and Machinability" (illustrated), by Dr. E. M. Trent. Halifax and Huddersfield Section. Percival Whitley College of Further Education, Francis Street, Halifax. Mon., 14 Nov., 7.30 p.m.

SHEFFIELD
"Types of Rolls for Modern Rolling Mills," by E. Hallas and R. Lee. Sheffield Section. Grand Hotel, Sheffield. Mon., 14 Nov., 6.30 p.m.

WOLVERHAMPTON
"Introduction to the Floturn Process" (illustrated), by E. J. Bennet. Wolverhampton Section. Wolverhampton and Staffordshire College of Technology, Wolverhampton. Wed., 16 Nov., 7.15 p.m.

Institution of Public Health Engineers

LONDON
"Organisation and Construction of Public Health Engineering Works," by Alan Osborne. Lecture at the Public Works and Municipal Services Congress and Exhibition. Olympia, W14. Tues., 15 Nov., 2.30 p.m.

Institution of the Rubber Industry

BIRMINGHAM
"Factory Safety Organisation," by W. H. Webb. Midland Section. Fort Dunlop, Birmingham. Mon., 14 Nov., 6.45 p.m.

PRESTON
"Polymers for High-Temperature Applications," by D. A. W. Izod. Preston Section. BTR Industries Social Club, Farington, Preston. Mon., 14 Nov., 7.15 p.m.

Institution of Structural Engineers

BRISTOL
"Characteristics of Friction Grip Bolt Joints," by M. S. G. Cullimore. Western Counties Branch. University Engineering Laboratories, University Walk, Bristol 8. Thurs., 17 Nov., 6 p.m.

LEEDS
"Multi-Storey Car Parks," by E. N. Underwood. Yorkshire Branch. Hotel Metropole, King Street, Leeds. Wed., 16 Nov., 6.30 p.m.

Junior Institution of Engineers

LONDON
"Simple Instruments for Tanks and Pipelines," Chairman's Address by E. M. Baskerville. Fri., 18 Nov., 7 p.m.*

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
Symposium on "The Reorganisation of Some Tyneside Shipyards"; papers by G. H. Houlden, R. Ibison, W. P. Heckels, P. Denham Christie and T. McIver. Mining Institute, Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 18 Nov., 6.15 p.m.

Presentation of Technical Information Group

LONDON
Open Discussion Meeting. University College London, Gower Street, WC1. Thurs., 17 Nov., 6.15 p.m.

Reinforced Concrete Association

LONDON
"The Code of Practice for Prestressed Concrete C.P. 115," by A. W. Hill. 11 Upper Belgrave Street, SW1. Wed., 16 Nov., 6 p.m.*

Royal Institution

LONDON
"Perception of Speech," by D. E. Broadbent. Fri., 18 Nov., 9 p.m.

Royal Meteorological Society

LONDON
"Some Recent Changes in Atmospheric Electricity and Their Cause," by K. H. Stewart; "Measured Radioactive Flux Divergence near the Ground at Night," by J. P. Funk. Wed., 16 Nov., 5 p.m.*

Royal Society

LONDON
"The Spectra and Structures of Free Methyl and Free Methylene," by G. Herzberg: Bakerian Lecture. Annual Report of the Council. Thurs., 17 Nov., 4.30 p.m.*

Royal Society of Arts

LONDON
"Coal Mining Situation Today," by F. G. Glossop. Cadman Memorial Lecture. Wed., 16 Nov., 6 p.m.

Royal United Service Institution

LONDON
"Britain in Africa Today," by Richard Goold-Adams. Wed., 16 Nov., 3 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Some Aspects of Hydrogen in Steel," by J. Hewitt. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 15 Nov., 7 p.m.

Society of Instrument Technology

LONDON
"Control of a Single Effect Concentrating Evaporator—Dynamic Characteristics and Analogue Computer Study," by F. P. Lees, L. W. A. Glasson and J. A. Anderson. Control Section. Manson House, 26 Portland Place, W1. Thurs., 17 Nov., 7 p.m.*

BRISTOL
"Instrumentation in the Red Brick Industry," by M. E. C. Stedham. Bristol Section. Department of Physics, University of Bristol, Royal Fort, Bristol 8. Thurs., 17 Nov., 7.30 p.m.

South Wales Institute of Engineers

CARDIFF
"Application of Electrical Engineering Principles in a Modern Tinplate Industry," by John Nelsey. Thurs., 17 Nov., 6 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Selection, Testing and Use of Steel for Caterpillar Tractors," by W. Sellars and W. J. Cormack. Fri., 18 Nov., 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9, Bedford Square, London, WC1. (MUSeum 1901)
British Interplanetary Society, 12 Bessborough Gardens, London, SW1. (TATe Gallery 9371)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Navigation, 1 Kensington Gore, South Kensington, London, SW7.
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Public Health Engineers, 179-181 Vauxhall Bridge Road, London, SW1. (VICtoria 3017)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289)
Presentation of Technical Information Group. Apply to Mr. B. C. Brookes, University College London, Gower Street, WC1.
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal United Service Institution, Whitehall, London, SW1. (WHItehall 5854)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)

Benchmark Resistant to Settlements

Set in the chalk 250 ft below ground level, a new ordnance survey benchmark has been established under London. The structure protecting the benchmark from movement is filled with oil and grease to prevent corrosion.

CONSTRUCTION of the "Shell Centre" on London's South Bank demanded a stable benchmark on the site so that measurements of the settlement of different sections of the buildings could be recorded. Some sections of the building are founded on deep cylinders and others upon rafts. It was also necessary to record the heave of the clay surrounding the Bakerloo Tunnels when the overburden was removed for construction of the basements.

For general surveys benchmarks are accurate to 0·01 ft, and the maximum error per mile in establishing a level is about 0·06 ft. For Ordnance surveys and more precise building work the errors tolerated are less than 0·01 ft per mile or less than one part in 428,000, which is better than much precision engineering. Until the erection of "Shell Centre" the nearest reliable benchmarks were in the Chiltern Hills, some 30 miles away from the site.

For the Shell site it was first necessary to relate the benchmark to the chalk 250 ft down below ground level and, secondly, its level had to be defined in accordance with existing benchmarks. To protect it from the ground movements it is surrounded by a tube which is telescopic and free to move. The tubing used is galvanised and the joints treated as they were made on site so that protection against corrosion is complete.

PERCUSSION DRILLING

A borehole was sunk by Le Grand Adsco Limited, of Southall, down to 25 ft into the chalk. A plain straight tube with an internal diameter of 6 in was embedded in concrete set in the chalk. Surrounding this tube there are three lengths of well-casing which overlap each other like an extended telescope. The bottom section has an 8 in inside diameter which allows only about $\frac{3}{8}$ in clearance around the inner tube. The middle section is 10 in and the top 12 in internal diameter. At each junction the overlap is about 4 ft so that, when any settlement takes place, the tubes will close up in telescope fashion without affecting the inner tube. The standard percussion method of drilling was used.

To ensure spacing between the inner and outer tubes small collars supporting rubber spacers are welded to the inner tube at 40 ft centres. These are able to bear upon the inner face of the well-casing and prevent lateral interference, while permitting free vertical movement of the outer casing relative to the inner tube.

The outer casing is slightly longer than the inner tube and is finished at the top in a manhole with inspection cover. It is also provided with a screw-on cap which is removed to reach the actual benchmark. The mark is a stainless steel bolthead placed in the upper surface of a screw cap closing the inner tube.

There remained three problems. First, the steel tubing had to be protected from corrosion for an indefinite period if the device was to be really useful. Secondly, water had to be kept out of the inner tube and the annulus surrounding it. Thirdly, whatever was done to secure the first two, conditions must aid rather than hinder the free relative movement of the outer casing and the inner tube. These three have been solved by filling the inner tube with Shell Tellus Oil 21—an oil containing anti-oxidation and anti-corrosion additives, and the annulus with Shell Alvania Grease1—a lithium base grease which contains an inhibitor of ferrous corrosion by water. This grease is not particularly stiff but the filling had to be done from the bottom upwards to avoid trapping air and to ensure that the space was, in fact, completely filled. As already mentioned, the clearance in the bottom section is only $\frac{1}{8}$ in and this extends for some 28 ft. The job was undertaken last November in extreme cold. Those two factors combined to present quite a problem to Becker Equipment and Lifts Limited who undertook the filling.

First, it was necessary to get a tube to the bottom. The tube used was a composite affair using Tecalemit high pressure grease hoses joined together for the upper sections and $\frac{1}{16}$ in outside diameter copper tube for the final 30 ft. This final length has a bore about $\frac{1}{4}$ in diameter presenting considerable resistance to the passage of grease over such a distance, even under ideal conditions. The resistance was even greater with the ambient temperature around freezing point during the whole operation.

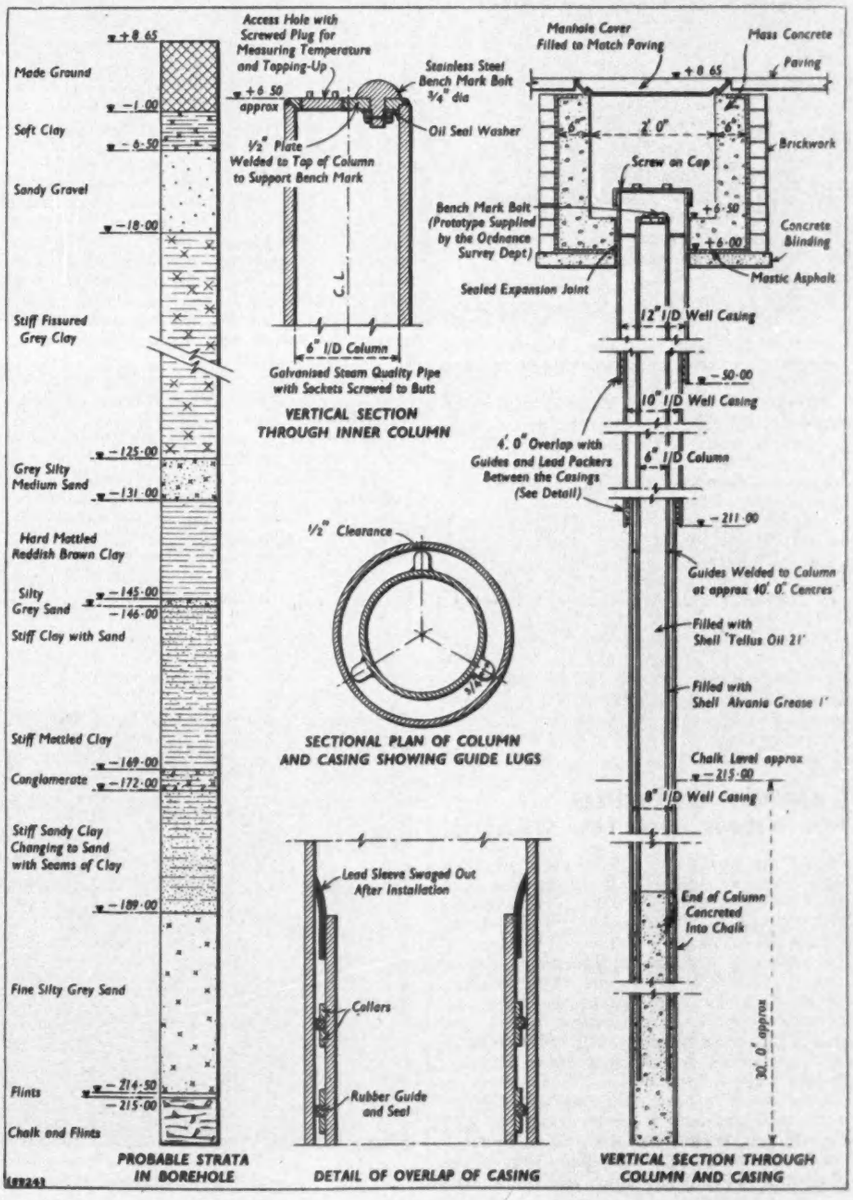
The pump used for the purpose was a Tecalemit HP10 high pressure drum pump operated from an airline unit on site delivering 200 lb per sq. in air pressure. Due to the low temperature in November it was necessary to work at a pressure of 6,000 lb per sq. in to force the 31½ cwt of grease required through the small bore tubing. Filling the inner tube meant merely pouring the oil in—a pleasant change for the operators.

ZERO TEMPERATURE CORRECTION

Now London has a new benchmark and, after a series of measurements using the Maihak vibrating wire thermometer, it has been established that it will not be seriously affected by temperature changes. The effect of expansion and contraction in the inner tube is extremely small compared with the degree of accuracy required and it will be ignored.

The design of the benchmark is the work of the consulting engineers for the Centre, Scott and Wilson, Kirpatrick and Partners of London.

Strata below the Shell Centre and details of the Ordnance benchmark established above the chalk.

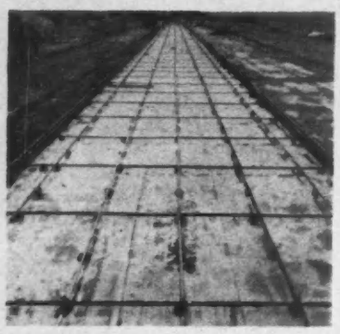

Made Ground
Soft Clay
Sandy Gravel
Stiff Fissured Grey Clay
Grey Silty Medium Sand
Hard Mottled Reddish Brown Clay
Silty Grey Sand
Stiff Clay with Sand
Stiff Mottled Clay
Conglomerate
Stiff Sandy Clay Changing to Sand with Seams of Clay
Fine Silty Grey Sand
Flints
Chalk and Flints
PROBABLE STRATA IN BOREHOLE
Access Hole with Screwed Plug for Measuring Temperature and Topping-Up
Stainless Steel Bench Mark Bolt ¾" dia
Oil Seal Washer
½" Plate Welded to Top of Column to Support Bench Mark
C.L.
6" I/D Column
Galvanised Steam Quality Pipe with Sockets Screwed to Butt
VERTICAL SECTION THROUGH INNER COLUMN
½" Clearance
SECTIONAL PLAN OF COLUMN AND CASING SHOWING GUIDE LUGS
Lead Sleeve Swaged Out After Installation
Collars
Rubber Guide and Seal
DETAIL OF OVERLAP OF CASING
Manhole Cover Filled to Match Paving
Mass Concrete
Paving
Brickwork
Screw on Cap
Bench Mark Bolt (Prototype Supplied by the Ordnance Survey Dept)
Concrete Blinding
Mastic Asphalt
Sealed Expansion Joint
12" I/D Well Casing
10" I/D Well Casing
4' 0" Overlap with Guides and Lead Packers Between the Casings (See Detail)
6" I/D Column
Guides Welded to Column at approx 40' 0" Centres
Filled with Shell 'Tellus Oil 21'
Filled with Shell Alvania Grease 1'
Chalk Level approx
8" I/D Well Casing
End of Column Concreted Into Chalk
30' 0" approx
VERTICAL SECTION THROUGH COLUMN AND CASING

Maintenance Area Taxiway at Gatwick

When Gatwick Airport was constructed in 1956-58, provision was made for the future extension of the maintenance area taxiway from the south-east corner of the area up to the east end of the runway. Work on the extension was started on site in March, 1960, and has now been completed. Part of the clay filling required for the taxiway had already been placed during the first contract.

The 60 ft wide taxiway is made up of four sections; there are three straight lengths, two 970 ft long and the third 250 ft long, which are of prestressed concrete; at the west end there is a right-angled bend constructed in 12 in thick concrete with dowelled longitudinal and expansion joints.

The foundation for the prestressed sections of the taxiway is partly of clay and partly of hardcore and on this there is a 6 in layer of imported



Pilot bay, 970 ft long, showing longitudinal and transverse ducts.

hoggin. The base for the prestressed pavement is lean concrete, 4 in thick, on top of which there is a ½ in layer of sand. The 6 in thick prestressed concrete surfacing is laid on building paper faced with polythene.

The concrete was laid in 15 ft wide bays which had ducts for transverse prestressing cables at 5 ft centres; holes were left at each longitudinal edge through which the ⅞ in diameter transverse cables were threaded. Each section was stressed longitudinally from both ends with no intermediate jacking; ducts were provided at 3 ft centres for the ¾ in diameter cables. The net working load carried by each of the longitudinal cables is 74,500 lb in each of the 970 ft long slabs, and 20,000 lb in the 250 ft slab; each transverse cable carries a load of 17,500 lb.

The consulting engineers to the Ministry of Aviation for the extension have been Frederick S. Snow and Partners of London, who also designed the airport originally; the contractors have been the Turriff Construction Company Limited of London, W2.

Calcium Chloride For Snow and Ice Control

During the winter of 1958-59, the New York State Thruway Authority, in conjunction with the Calcium Chloride Institute, experimented with mixtures of calcium chloride and rock salt to help get rid of snow and ice. The object of the work was to obtain (*a*) information on the time of the melting action and its effectiveness, (*b*) data on the economy of materials, and (*c*) information on the handling, storing and application of the mixtures. A full account of the experiments is contained in a Highway Research Board bulletin No. 252, *Snow and Ice Control with Chemicals and Abrasives* (available from the National Research Council, 2101 Constitution, Washington, DC, USA, $0·80).

Considerable benefits were found with the use of the calcium chloride, which was applied as a mixture with rock salt, the proportions being one of the calcium chloride to two of salt by volume (this represents about one to three by weight, but it was found more practical to work in volumes). The calcium chloride greatly speeded up the melting action, and the report emphasises that the mixture is better than either ingredient used independently. The economies of the method are still to be fully evaluated and more work is to be done this coming winter to test the advantages of adding sand abrasives to the chemical mixture.

Fatigue Test On Prestressed Apron

The prestressed concrete apron in front of the hangar for Transair Limited at Gatwick Airport covers an area of 290 ft by 230 ft. It was constructed in 1957-58, and has thus been in service for two years. Several months after the apron was completed it was subjected to a series of loading tests by the Road Research Laboratory (DSIR). The slab was shown to be sound and that cracks formed under load closed up when the load was removed.

The 5 in concrete slab was laid on two layers of waxed paper on a base of lean concrete 3 in thick. It was placed in bays normally 15 ft wide, to the full 290 ft length of the apron. Freyssinnet cables were used for prestressing, each consisting of 12 wires of 0·2 in diameter; the cables were placed at 3 ft centres longitudinally and at 5 ft centres transversely. At the edges of the slab there were precast concrete edge beams, through which the prestressing cables passed.

A complete length of a bay was concreted in one day and on the following day three of the five longitudinal cables were stressed to prevent shrinkage. Initially, alternate bays were laid; the transverse cables were then threaded through the transverse ducts formed, and sheathed across the remaining bays. Three days after all the concrete had been laid, the remainder of the longitudinal cables were stressed, followed by the transverse cables.

The apron was extended at the north-west corner, after the main apron had been completed but before the stressed cables had been trimmed. The cables were lengthened using Gifford-Udall double-ended anchorages.

Most of the tests made by the Road Research Laboratory were sited adjacent to longitudinal construction joints, as these were considered the weakest part of the apron; 1,000 applications of a load of 19 tons on an 18 in diameter plate (equivalent to LCN 60) produced only slight spalling at the joints. Repeated loading of 27·5 tons (LCN 100) produced cracks which closed after removal of the load. A single application of 69 tons followed by 25 applications of 51·7 tons produced no cracks.

The Refinery That is Landscaped

The Esso Petroleum Company's refinery at Milford Haven—opened last week by the Duke of Edinburgh before a gathering of 1,400 guests—is sited in a "bowl" so that, apart from the chimneys and the tall refraction towers, it is largely hidden from sight, leaving the countryside unspoilt by its presence. Even the wastes are burnt off in a ground stack with multiple burners that achieve almost 100 per cent combustion and give no more than a red glow at night. With the refinery occupying only 350 acres out of the company's 1,100 acre holding, and by farming the remainder and building a sports ground on the town side, Esso have done all they can to ensure that the refinery does not obtrude into any of the amenities of the area.

It is a "simple" refinery—though highly automated with only 25 operators working at three control points required per shift—with a current capacity of 4½ million tons of Middle East crude oil a year. The designs have been such that, should the condition develop favourably, the capacity could be increased three-fold to equal the throughput of Fawley, now the largest refinery in the Commonwealth. The principal products will be a complete range of motor, aircraft and industrial fuels plus feedstocks for the plastics trade.

Apart from the landscaping, advantage has also been taken of the contours to so site the 69 process and storage tanks that all spillage drains to a common skimming pool; by virtue of this layout authorisation was obtained to build the tanks without fire bunds—a worthwhile construction economy. The refinery is also distinguished by possessing the largest boilers in Europe (equalled only by units at Rotterdam) and by using air cooling of the hot products. Characteristic of the refinery is the minimum use of buildings—all the plant is exposed to the weather—another cut in costs.

Many details of the refinery have already been given in an earlier report (ENGNG., 16 Oct. '59, vol 188, p. 346). As the Esso photograph reproduced below shows, the refinery possesses a magnificant marine terminal able to accommodate two tankers of up to 100,000 dwt each, as well as additional smaller coastal vessels (which take away around 98 per cent of the refinery's products). The approach trestle, 3,500 ft long, and the mooring heads are of precast concrete construction built above prestressed tubular piles fabricated nearby.

The principal contractors for the construction were Foster Wheeler Limited, George Wimpey and Company Limited (earthworks, buildings and roads), John Mowlem (the marine terminal), Whessoe Limited, W. Neill and Sons (St. Helens) Limited, and the Motherwell Bridge and Engineering Company Limited.

Esso's refinery and marine terminal for 100,000 ton tankers at Milford Haven.

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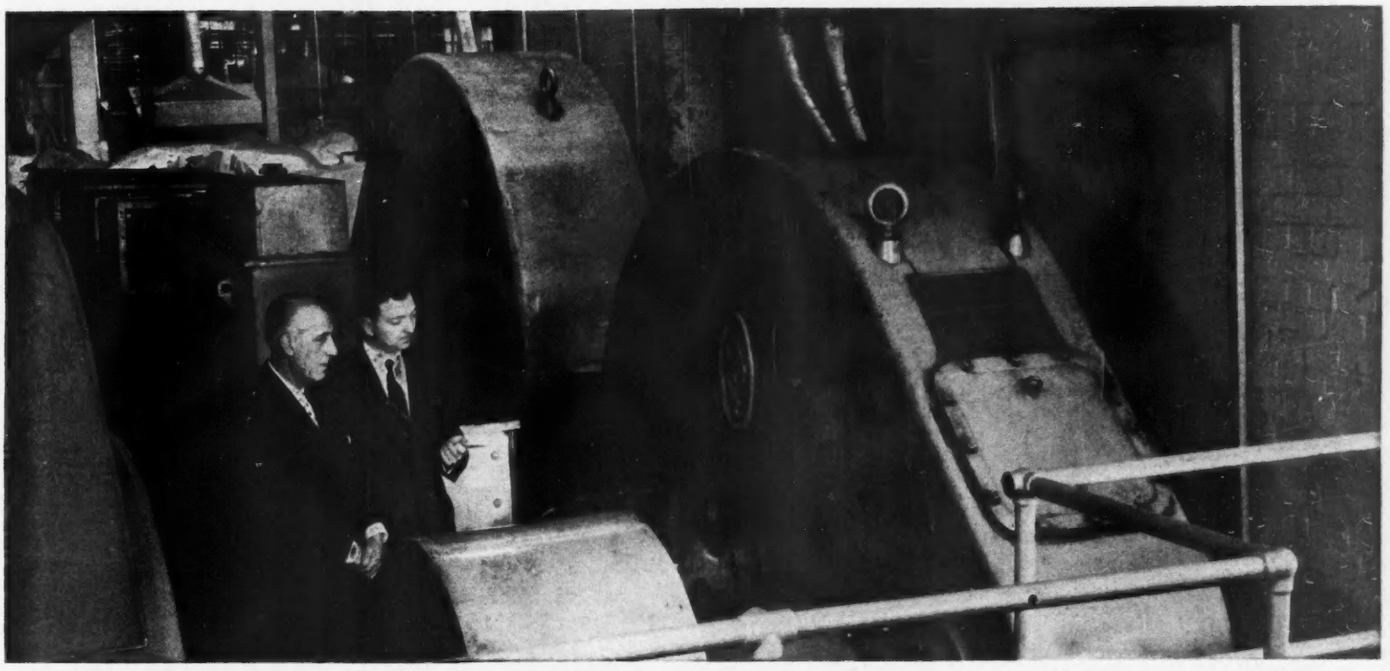

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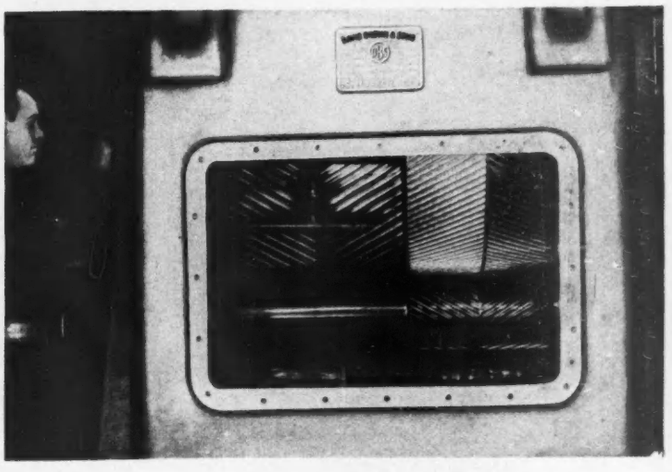

(Top) Regent Sales Engineers at the Dunlop factory, Birmingham.
(Inset) The 600 H.P. Double Reduction Speed Reducer in this picture at the Dunlop factory in Birmingham is driving a Mixer. Dunlop have found Regent Oil ideal for the efficient lubrication of these gears.
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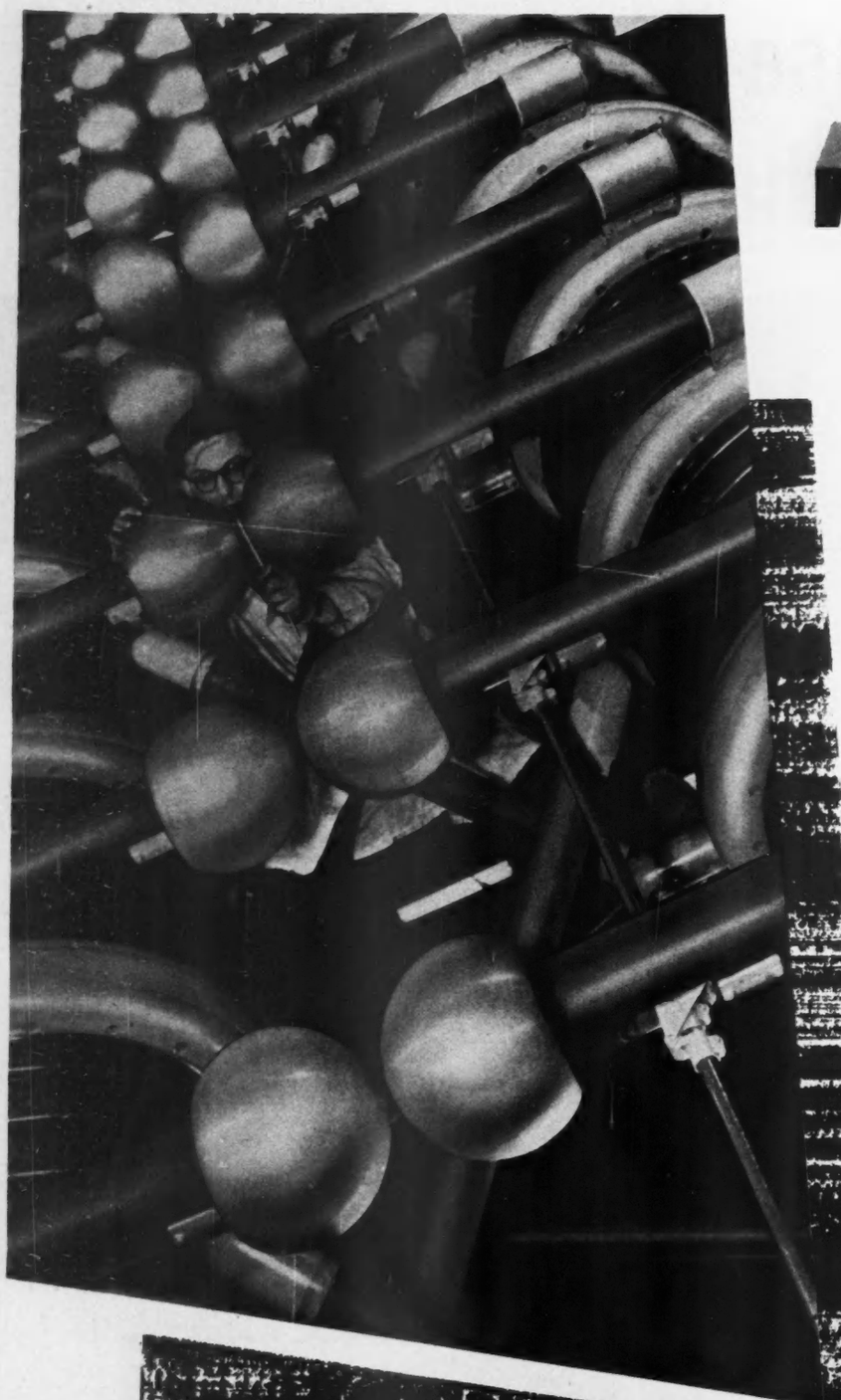

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Human Element

No Relief Offered To Car Chiefs

MR. SELWYN LLOYD, the Chancellor of the Exchequer, and Mr. Reginald Maudling, the President of the Board of Trade, held out no hope of rapid relief from the credit restrictions when they saw a deputation of motor car chiefs at the Treasury last week.

Neither could Mr. Lloyd see his way to making any change at present in the rate of purchase tax levied on motor cars.

The nine-man motor manufacturers team was with the two Ministers for more than an hour and a half. They were led by Mr. Geoffrey Rootes, the president of the Society of Motor Manufacturers and Traders.

With Mr. Rootes were his brother, Lord Rootes, Mr. G. W. Harriman, of the British Motor Corporation, Sir William Lyons and Sir William Black, Mr. A. S. Dick and Mr. P. W. Copelin.

A TUC Voice on Power in the Unions

There is no such thing as a typical British trade union.

Or at least, not in the opinion of Mr. George Woodcock, the general secretary of the Trades Union Congress. In its way, this makes all the more curious his criticism of the National Union of Railwaymen as being "rigid and unBritish."

UnBritish is a term not in common use. If it stems from across the Atlantic then the epithet "unAmerican" was one familiar in the diatribes of Senator McCarthy, whom United States leaders were among the first to oppose.

Mr. Woodcock's point was that the NUR believed with passion in industrial unionism, to the exclusion of craft and "general" unionism. This attitude the TUC general secretary thought to have prevented cooperation inside the railway service and to be "rigid, unBritish and theoretical."

So far as the TUC were concerned, Mr. Woodcock explained that size and type were not regarded as important. Unions were taken as they came, whether small or large, craft, industrial or general. There was no such thing as a typical British trade union.

This is not an argument that squares with the existence of the block vote. Mr. Woodcock emerged on to safer ground when he went on to tell his Leicester audience that the concentration of power in the central executive is no longer relevant to existing conditions.

The real power wielded by shop stewards is a live issue, even if the effects are perhaps far less than is commonly supposed. The more a union leadership retains the power at the centre, at some unavoidably remote London headquarters, the more the extremists in the branches are able to have things their own way in the day to day affairs of their industry.

And this is 95 per cent of what the trade union is for. Mr. Woodcock used the phrase, "once it [the unions] had achieved original purposes like full employment disintegration set in." If the people of the United Kingdom are fully employed it is at least as much due to overseas demand for our goods as to domestic pressure from the unions. What is wanted is some of the zeal of United States unions for productivity and for the efficiency of the firms in which their livelihood is involved.

It is rather late in the day, but while it is open to doubt whether the defence debate of the TUC annual conference was of any use at all, it is incontrovertible that the same time devoted to an emergency discussion of the British shipbuilding industry, for example, would have been of at least some benefit.

Travellers from Saturn With a German Accent

People will, of course, hold a conference on almost any conceivable subject, and some that are quite inconceivable. It is not clear into which category falls the recent Bonn, West Germany, conference described as the fourth international unidentified flying object congress.

This was not a convention for those whose aircraft spotting is poor and cannot tell a Douglas DC8 from an Ilyushin. It was for instance attended by a Dr. Anderson who years ago in the Californian desert was spoken to by a man named Kumar, who turned out to be an ambassador from Mars travelling by flying saucer.

From the same part of the United States — Hollywood — Dr. Reinhold Oschmidt recalled finding a 90 ft long flying machine in Nebraska in 1957. It was manned by four men and two women, all from Saturn and curiously enough they spoke English with a pronounced German accent. (Perhaps that is where Martin Borman went after the war.)

Dr. Oschmidt said that he flew with the Saturn folk and they were able to identify underwater navigation aids for Soviet submarines off the Canadian and United States coasts. These were reported to the Pentagon and later destroyed.

On this point the Pentagon is silent. Whether with embarrassment or astonishment is not clear.

South Africa and The Skilled Immigrant

A puzzled plea reaches ENGINEERING from an engineer in Durban, South Africa, recording that his firm needs a Senior Technical Assistant but the friends in England who are looking for one find that "people do not want to go out to Africa."

Where has the pioneer spirit gone, asks the correspondent.

There is a confused situation here and one that may go on becoming more and more difficult. Britain has a special place, and the least vocal of her citizens are affected by it, as the founder of Parliamentary democracy. The Second World War alone demonstrated the willingness of the nation to risk its existence and expend its wealth defending its freedom.

Unless there is a feeling in South Africa that all this means nothing there can hardly be any surprise there if the sort of man they are looking for is not ready to go. If there is an unwillingness on the part of certain United Kingdom people to go out to South Africa it is not for lack of pioneering spirit, it is more likely to be lack of affection for a state apparently casting away all the standards for which their nation has fought in the past and still upholds.

The situation becomes more complicated when it is recalled that after the United States and Canada, South Africa is Britain's third largest market for the export of motor cars. The emigrant, especially the technically qualified, is an excellent ambassador for trade.

If others take the place of the missing British immigrant, their home country is likely to get the benefit of a man on the spot who knows the exporting companies and is naturally inclined in their direction. But this argument is not likely to resolve the situation.

If there is a conflict between fair play and trade interests those who have thought for a moment about the British record would have little doubt about the outcome.

Forgotten Engineers of Waterloo Bridge

Could a well informed member of the public name a single living civil engineer? Sir Herbert Manzoni, President of the Institution of Civil Engineers and Birmingham's city engineer, doubts it. He is not particularly sure that a member of the public could even describe what a civil engineer does.

These melancholy opinions were given by the ICE President in his address earlier this month. He raised the reasonable question of why Waterloo Bridge was ascribed to one "great in other spheres but who did not, and could not, build it" (presumably Lord Morrison), while its engineers remained unnamed.

Telford, Brunel and the other great engineers of the last century enjoyed a more individualistic world, of private endeavour and free enterprise, where investment capital was largely in private hands—hands that were therefore able to take risks.

Guaranteed Demand

Pausing for a quick look at the Welfare State, Sir Herbert said: "The money available for large projects is now controlled by the State or by banks, insurance companies and the colossi of business, none of which will, or dare, risk it, except on projects the success of which is practically guaranteed by a large unfulfilled demand which has been amply demonstrated. Even the Government in these days seems to require a popular demand which might be reflected in votes before it takes effective action."

In a world increasingly given to committees, groups, teams and other ant-like activities, would the profession of civil engineering suffer "continuing loss of recognition and of influence" because men of outstanding stature either fail to appear or are submerged by the trend to communal thought and action?

Sir Herbert did not think so. The men who had established the status and reputation of the profession had used the resources and the appropriate methods of the times. In emulating their achievements in this age it would be necessary to use the resources to hand, or better still those swiftly developing and becoming available.

Amalgamation

As a municipal engineer, in the year when decisive steps in amalgamation of the civil and the municipals are going forward, it was natural for Sir Herbert to dwell at length on some current problems among municipal engineers, upon whose shoulders an immense range of responsibility falls.

The ICE President pointed to his own 800 strong staff at Birmingham. This includes engineers of many specialisations—civil, mechanical, electrical, structural, heating and ventilation. There are also architects, town planners, building surveyors, chemists, physicists and geographers and sociologists. Supporting the team are land surveyors, reference clerks, inspectors, accountants and the secretarial staff.

There is a clue here to the breadth of expert opinion that may be expected from municipal engineers, even when they have not the wealth of support that Sir Herbert Manzoni is able to draw upon.

Pollution and Traffic

This means that the municipal engineer, who may not be a specialist in traffic engineering, nor in industrial pollution, may be responsible not only for controlling the work but in giving the advice which will lead to the work being undertaken. Almost 2,000 local authorities in the United Kingdom employ a municipal engineer as a chief officer. Between them they spend more than £500 million every year on public works.

In the controversial field of traffic engineering, Sir Herbert believes that there are few, if any, experts on the subject, involving, as it does, many factors of local experience. For all that, the municipal engineers are expected to advise on the best solutions. In most cases their advice will be followed. This was a heavy responsibility which had to be faced since the municipal engineer was in the most favourable position to know the facts and the probabilities.

The serious pollution of watercourses and sewers was also a comparatively new problem for municipal engineers to solve. In time traffic engineering and industrial pollution may themselves become specialities as water supply, transport and town planning have.

Finnish Power Party Visiting CEGB Plants

A three-man delegation from the Finnish State Power Board was last week entertained by the Central Electricity Generating Board.

The Fins saw High Marnham power station, near Retford, and watched the 200 MW generating set functioning.

The next day they went on to the 300 MW nuclear power station under construction at Bradwell, Essex, following this with a look round the Calder Hall establishment of the Atomic Energy Authority.

The three power men were Mr. Laurila, director of the electrical department and director of the Finnish State Power Board; Mr. Tauno Rask, a thermodynamic specialist; and Mr. Raimo Tuuli, a nuclear engineer.

PUBLIC WORKS EXHIBITION

Olympia, London, 14 - 19 November

This year's Public Works and Municipal Services Congress and Exhibition (to give the full title) is the eighth in the post war series. The exhibition was first held in 1919. Some 400 groups and companies will have stands over a floor area of 245,000 sq. ft. While the exhibition is open there will be more than 20 congress sessions; papers and discussions will include traffic engineering, estate development and water supply. All are open to visitors.

TOWER CRANE

EASY transport and quick erection are features of a new Pingon tower crane.

The P8-612 has been designed for the erection of two and three storey flats and maisonettes. It has a capacity of 12 cwt at a radius of 39 ft 4½ in. It is of the self-erecting type and is mounted on a pneumatic tyred chassis suitable for towing. The tower is mounted on a slewing ring at the base and the ballast is carried on the rear of the slewing platform.

Normally the crane is operated with the jib horizontal. If, however, greater height is required than the 42 ft which this gives, the jib can be luffed upwards with the trolley locked at the end of its travel. This gives a fixed radius of 28 ft 6½ in with a height under the hook of 68 ft 3 in. The load capacity remains unchanged at 12 cwt. *George Cohen, Sons and Company Limited, Wood Lane, London, W12.*

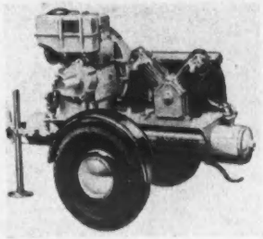
AIR COMPRESSOR

Trailer Mounted

PORTABILITY and compactness are two claims for the PD52 air compressor.

The machine is capable of powering a light breaker for road repair work and will also operate a wide variety of other pneumatic tools such as chipping hammers and hedge clippers. It is a V twin cylinder machine and air cooled. The piston displacement is 52 cu. ft per minute and the delivered capacity is 40 cu. ft per minute at 80 lb per sq. in pressure. Power is supplied by a Lister SL2 diesel or a JAP 55B air cooled petrol engine driving through four V belts.

The air receiver is 8 in diameter and 5 ft 2 in long giving a volume of 2·2 cu. ft. It is supplied complete with pressure gauge, relief valve, twin take-off cocks, and drain cock. A large pulsation chamber connected to the receiver through special gilled-tube aftercoolers, the cooling for which is supplied by the fan type vane flywheel, keeps the discharge temperature low. The valves are made in



special steel and have titanium valve plates to give high efficiency and output per horsepower. Other features of design include a counterbalanced drop forged crankshaft carried on large ball bearings, dual air filter/silencers, foolproof lubrication system and automatic air governor.

The two wheels are fitted with 4·75 in by 16 pneumatic tyres and overrun brakes. An adjustable supporting leg enables the outfit to stand horizontally when working or parked. A tow bar and towing attachment are provided. The overall length is 7 ft 10 in and width 3 ft 4 in. Weight with the diesel engine is 1,144 lb. *Broom and Wade Limited, PO Box No. 7, High Wycombe, Buckinghamshire.*

GRADER

Efficient Hydraulic System

TWO graders on exhibition are the Wakefield 120 (illustrated) and a smaller model, the 603.

Both machines have been the subjects of recent improvements. The model 120 now has a base weight of 25,040 lb and has had the front end altered to simplify the attachment of bulldozer and snow plough fitments. A T-type drawbar of increased strength has been introduced which allows increased clearance for scarifier operations. A new pitch adjustment for moldboard and scarifier consists of a racked slot which enables adjustments to be effected quickly, the bolts being positively retained in the rack. Considerations of servicing have been incorporated throughout and easier access and new positioning of oiling points are two improvements.

The power unit of the 120 is the Leyland AU600 diesel engine which develops 130 b.h.p. at 1,800 r.p.m. A particular feature claimed for the graders is the weight distribution which is designed to give maximum tractive effort and blade pressure with a heavy front end for good flotation. The standard drive is by chains, though all-gear drives can be provided if required.

Another feature is the hydraulic system said to be simple but effective. It controls all grading movements and gives boost to the combination steering. Blading movements are said to be smooth and positive and free from creep. The moldboard can be raised up to 90° in the vertical plane to left or right of the grader for high bank sloping.

A wide range of optional fitments includes hydraulically shiftable moldboard; scarifier, bulldozer, snow plough, cabs and four wheel brakes. A creeper gear is also available for extra slow speeds for special grading jobs. *Construction Machinery Limited, Wakefield, Yorkshire.*

JAW CRUSHER

Non-Rubbing Action

THE range of Kue-Ken jaw crushers is now being made in this country.

The illustration shows the largest and the smallest machines. The largest has a capacity of 310 tons per hour and jaw settings of 8 in to 11 in. The feed opening is 42 in by 36 in. The frames are welded steel and the jaw plates are manganese steel. Various forms of jaw are available to suit different crushing conditions. Jaw settings can be easily and quickly adjusted without altering the geometry of the toggles.

The hinge pin that carries the swing jaw runs in an oilbath, and a non-rubbing flexible diaphragm seals the opening to the bath from the crushing chamber. Lubrication is by a pump with a filter in series. Oil is drawn from the lower end of the bath where it has had time to cool. The mechanism is totally enclosed in a steel housing formed by the frame side plates and the bottom plate.

It is claimed for the design that the long stroke of the eccentric shaft and the relatively flat toggles running at high speed develop sufficient leverage to obviate the need for a heavy flywheel. Normal speeds are in the region of 300 r.p.m. The pitman is simple in design and acts always in compression, bearing only on the lower side of the eccentric shaft.

The largest machine requires from 60 to 75 h.p. to drive it and the weight is approximately 46,590 lb. A safety device is incorporated to prevent damage due to the presence of tramp iron in the feed. It is claimed that the comparatively high rate of stroking makes for more evenly crushed rock. *Armstrong-Whitworth (Metal Industries) Limited, Gateshead upon Tyne 8.*

TRAILER DUMPER

Hydraulic Operation

HYDRAULICALLY operated, the new Leedsall trailer dumper has been designed for use with the Fordson Major and other tractors.

It is claimed that the unit represents a saving in weight and cost compared with more usual truck types. It has been designed to give a high all round performance, and the draw bar linkage system allows complete articulation in all directions with a 90° swing in both locks. The draw bar, which is the subject of a patent application, allows the tractor-trailer combination to articulate within the stability of each unit and gives the complete outfit a turning circle of only 30 ft making it easily manoevrable.

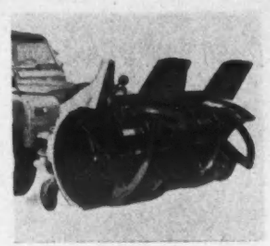
Maximum tractive effort is achieved on the driving wheels of the tractor and the front axle steering is stable with the trailer empty or loaded. The unit is compact with an overall length of 22 ft 10 in; the wheel base from tractor rear axle to dumper axle is 12 ft 3 in. The height of the body is 8 ft (rising to 11 ft 8 in in the dumping position) and the overall width at the rear tyres is 7 ft 6 in. The body capacity is 7 cu. yd.

The body is made of ¼ in steel plate fabricated and welded throughout and is reinforced with ⅜ in press-brake-formed channel section stiffeners. The struck capacity is 5 cu. yd and the rated loading 10 short tons (20,000 lb) although this has been exceeded up to 10 tons 7 cwt. No fixture or side boards are needed for the body when carrying maximum loads.

The chassis is made of heavy section A form construction using 9 in. by 3 in rolled steel channel. The wheels of the trailer are fitted with 1,400 by 24, 12 ply rear tyres of the earth moving type and have cast steel hubs, taper roller bearings, and Girling air brakes fed by a compressor mounted on the tractor. *Robert Hudson Limited, Raletruc House, Meadow Lane, Leeds.*

SNOW PLOUGH

Hydrostatic Transmission



THE rotary snow plough illustrated is designed for use with a modified Land Rover.

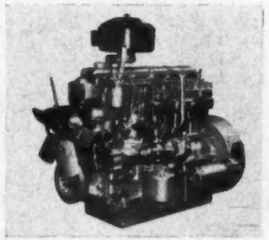
The plough has a clearing width of 6 ft 7 in which is wide enough for most private cars. The modification to the Land Rover involves the provision of a drive shaft to the front to operate the plough and the addition of a small hydrostatic transmission to propel the vehicle forward during the actual ploughing operations.

In driving to the site the Rover is driven normally through the main gearbox and the rotary attachment is carried separately on a trailer. On arrival at the working site the plough is fixed at the front of the Land Rover and the propeller shaft and hydraulic system coupled up. During ploughing the main engine of the Land Rover drives the plough through the propeller shaft, and the road wheels of the vehicle are driven by a small auxiliary engine through a hydrostatic transmission developed by Hydrostatic Transmissions Limited. Joseph Lucas Limited, and the Rover Company Limited also cooperated with Aktiengesellschaft Rolba to produce the complete machine.

The arrangement allows a steplessly variable range of ploughing speeds from 0 to 4·5 m.p.h., with very smooth take up and control. By detaching the rotary plough the Land Rover can be used as normal vehicle for other purposes so that the complete unit is not confined to use during winter. Cost is also reduced by the omission of a large engine for driving the plough, and the omission of a special low ratio creeper gearbox. As far as possible standard parts from other ploughs in the range have been used in this version. *Rolba Limited, 88-92 Rochester Row, London, SW1.*

INDUSTRIAL DIESEL

112 b.h.p. Rating



AN industrial version of the Six 354 diesel engine is rated at 112 b.h.p. at 2,800 r.p.m.

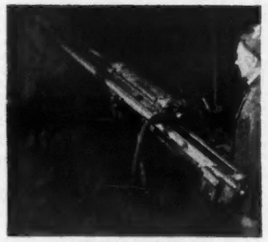
The direct injection engine has six cylinders of 3⅛ in bore by 5 in stroke, giving 5·8 litres capacity. The maximum torque of 266 lb-ft is developed at 1,450 r.p.m. at maximum intermittent rating, and 234 lb-ft at 1,300 r.p.m. for continuous operation. The higher figures are for intermittent use when a hydraulic governor is fitted.

The cylinder liners are cast iron, pressed in, and run dry. Thin wall prefinished steel backed copper lead main bearings are used and the crankshaft pin and main journals are induction hardened. The low level camshaft has chilled cams and is supported by four bearings machined in the cylinder block. A distributor type fuel pump is mounted vertically and driven through worm and worm wheel from an auxiliary shaft. The engine can be fitted with a hydraulic governor for variable speed applications or with a mechanical governor for continuous running to close speeds. A positive engine timing drive is obtained through helical gears.

Power take-offs can be made from several points. A light drive can be taken from an extension of the fuel pump layshaft at the rear for such light auxiliaries as an exhauster or power steering pump; a heavy duty drive is also available from this position for larger hydrauli. pumps. When required, power can be taken from the front end of the crankshaft. The bare engine weighs 836 lb; flywheel starter, fan and cleaner add another 264 lb. It can be supplied alone or as a complete power pack. *F. Perkins Limited, Peterborough.*

DRIFTER

Reversible Rotation



THE SL160 has been designed for deep hole drilling in rock or other material.

The machine is provided with reversible rotation to assist in the coupling and uncoupling operation of jointed drill steels. The illustration shows the machine mounted in a light alloy cradle for deep hole drilling underground. The locked-in shank has long bearing surfaces on either side of the lugs to maintain good alignment of the drill steel. This drifter can use rods of 1¼ in round, 1¼ in round or 1¼ in hexagon section without special adaptation so that a wide choice of drill steels is possible.

A large diameter water tube is ring sealed in the drill shank. This allows a good flow of flushing air or water to be maintained to the drill point. It also prevents any escape at the shank and ensures that the full pressure is maintained the whole length of the drill.

The direction of rotation is determined by setting a lever at the back end of the drifter, but control of the operation and of the blowing is by a separate cock which can be situated wherever is most convenient for the mode of drilling being employed in any particular operation.

The screw fed cradle mounted model is driven by the largest of the company's motors, the Mark IV. This is also claimed to be the most compact. It has ample power for withdrawing drill steels from depth and its compactness, which reduces overall cradle length, gives it advantages for using the drifter in confined spaces.

The SL160 has a 4 in bore and a 3 7/16 in stroke. Its weight with shank end is 150 lb. *Holman Brothers Limited, Camborne, Cornwall.*

DELIVERY TRUCK

Mixed Concrete

READY mixed concrete can be delivered to site by the truck-mixer/agitator " Rex."

The " Rex " has a capacity of 4/4½ cu. yd of concrete and, like others in the range, a high discharge height with a 16 ft spouting range. Delivery can be at any point over an angle of 150°. The drum incorporates a " shrink " blade and the two axle short wheel base works within the 14 ton gross vehicle rating.

The charging hopper is the fixed open end type having the advantage of light weight and no moving parts. A choice of drive is available for the drum using either a front engine power take-off or an independent diesel unit. The diesel engine is a Standard 23CV four cylinder unit developing 45 b.h.p. at 3,000 r.p.m. As far as possible the parts have been standardised with those of the 6 cu. yd model.

The purpose of the shrink blade is to impart reverse mixing action as the drum rotates, to clear the way for the materials to enter. The low drum angle is said to provide maximum air space above the batch for quick mixing, which is also helped by the large capacity water pump. The low drum angle also speeds up discharge.

The main drum bearing is mounted in a self aligning ball and socket unit with taper roller bearings. At the discharge end are two wide faced forged steel rollers, flame hardened. A hold-down roller counteracts any upward movement due to chassis bounce. There are three possible water systems; two compartment syphon tanks; flush tank; or side mounted pressure flush tank. A wide range of accessories is available. *Blaw Knox Limited, 90-94 Brompton Road, London, SW3.*

DUMPER

On or Off Road Operation

DUMP truck type 944 is designed for heavy duties on or off the road.

The scow-ended body has a struck capacity of 6 cu. yd or of 8 cu. yd when heaped. The frame is made of rolled steel channel longitudinals with four full depth cross members. The floor is the sandwich type with the top steel plate bolted for easy removal. A hardwood floor 1¾ in thick is interspersed between top and bottom plates. The body will tip to 75° by the double acting hydraulic gear, under control of a lever in the driver's cab.

Power is supplied by a three cylinder opposed piston two stroke horizontal diesel engine developing 105 b.h.p. Transmission is by a 13 in dry plate clutch and a four speed synchromesh box with reverse. An auxiliary two speed box gives low ratios for off the road work. The maximum gradient is 1 in 3.

The wheelbase is 9 ft 6 in and the overall length 16 ft. The overall width is 8 ft and the height 9 ft. Front and rear track are both 6 ft 2 in. Steering is by cam and double roller (arranged for right hand drive) and the turning circle is 40 ft approximately. Suspension is by heavy duty semi-elliptical laminated leaf springs at both front and rear. There is direct air pressure braking to the rear axle and proportional hydraulic air braking to the front. The all steel cab has safety glass all round and gives forward control. *Douglas Equipment Limited, Kingsditch Lane, Tewkesbury Road, Cheltenham, Gloucestershire.*

ASPHALT PLANT

Automatic Operation

AUTOMATIC batching plants for asphalt are now available with dial controls.

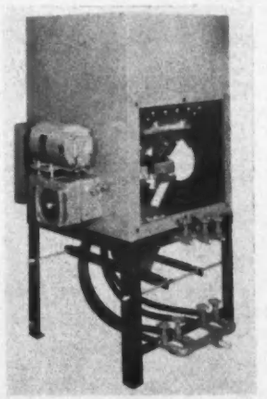
The Batchomatic series of asphalt plants are claimed to give greater tonnage outputs with more even mixing. Only the wet and dry mixing cycles are controlled by timers, all other operations being initiated by sequence relays which bring each function into operation as soon as the previous one is finished.

The tower section of the plant is illustrated. In it is a vibrating screen of 3½ decks allowing a selected proportion of fines to be included in each mix. The proportion is controlled by a dial setting. There are four weigh hoppers to cover different sizes of aggregate and weigh buckets for metering in the asphalt. A Dyna-Mix pug mill mixes the ingredients and the oversize discharge gate with which it is fitted gives very rapid discharge to prevent segregation. Any standard mix can be preset on the controls.

All valves are operated hydraulically under electrical control, thereby reducing the length of piping required and simplifying maintenance. The binder content is under dial control. The storage bin strike-off gates are hydraulically operated and are said to give accurate sampling without interfering with the operation of the plant. Other sections of the complete plant include aggregate feeder, rotary dryer, and dust collector. *Barber-Greene, Olding and Company Limited, Hatfield, Hertfordshire.*

DRY FEEDER

Pneumatic Distribution



ACCURATE metering of dry chemicals and their fluidisation for distribution can be obtained in a recently introduced volumetric feeder.

The chemical to be fed is put into the hopper of the machine, which is equipped with an oscillating diaphragm agitator to prevent arching and packing. The hopper has a capacity of 3½ cu. ft. The feed screw is the self cleaning type with positive displacement and produces a constant rate of feed. A wide operating range is controlled by a knob connected to the feed register.

From the screw the powder enters the pneumatic unit where it is fluidised. In this form it can be conveyed to one or more points of application. The powder/air mixture can then be applied to a standard form of agitator for mixing with bulk material as in the case of a blending plant. Alternatively, the unit may be used purely as a means of conveying measured quantities of material from the feeder to remote or inaccessible points of the plant. All materials used in the construction of the apparatus are corrosion resistant so that maintenance is reduced to a minimum. The feeder is driven by a ½ h.p. motor and typical feed rates are from 0·25 to 25 lb of carbon or 1·0 to 118 lb of soda ash per hour. *Wallace and Tiernan Limited, Power Road, London, W4.*

Developing an Oil for Automatic Transaxles

Some 34 years of development have gone into present day lubricants for hypoid gear axles, and about 23 years have been spent on automatic transmission fluids. Now the problem is with us of developing a fluid combining the properties of both fluids. For, in combining the transmission and axle mechanisms into a transaxle, it is logical to consider the use of a single lubricant rather than one for each of the two parts of the unit.

General Motors Research Laboratories have been working on transaxle fluids for several years. Some of the results are set out in a paper "Developing Transaxle Fluid," by N. A. Hunstad, R. A. Wilkins, R. E. Osborne, and E. D. Davison (presented at the annual meeting of the Society of Automotive Engineers, Detroit). The lubricant requirements depend on the type of transaxle. It seems likely, however, that hypoid gears will be preferred to spiral bevel gears. It is clear, also, that the most difficult problems arise in automatic gearboxes.

The various requirements that have to be met by a transaxle fluid in comparison with axle and gearbox fluid are shown in the table. The main difference is that transaxle fluids must not only meet the requirements of the automatic transmission fluid but also have good extreme-pressure performance. The latter protects the hypoid gear where high sliding velocities and pressures occur. Unfortunately experience indicates that good extreme-pressure performance is an opposing requirement to that of clutch plate lubrication.

The Relative Importance of Lubricant Properties

	Automatic transmission	Rear axle	Transaxle
High-temperature viscosity	major	intermediate	major
Low-temperature fluidity	major	intermediate	major
Shear resistance	major	minor	major
Friction properties	major	intermediate	major
Oxidation resistance	major	intermediate	major
Anti-foam quality	major	intermediate	major
Effect on seals	major	major	major
Clutch-plate compatibility	major	minor	major
Anti-wear quality	major	major	major
Anti-corrosion quality	intermediate	intermediate	intermediate
Extreme-pressure quality	intermediate	major	major

To narrow down the field of research, General Motors decided to concentrate on developing a lubricant for use with phosphate-coated gears. They point out, however, that while the preponderance of their experience indicates that phosphate coating is beneficial, it is possible that a specific lubricant may work better with non-coated gears.

The first transaxle fluid to be evaluated was a mineral-oil-base product. It was similar to automatic transmission oil but had a higher extreme-pressure rating. Tested in an axle it gave good performance. However, when tested in a Powerglide transmission in a car, malfunction of the transmission occurred in less than 50 miles of driving. The cause was severe flaking and glazing of the clutch plates. Subsequent testing confirmed that the fluid and the clutch plates were incompatible.

This test showed that much more experience was needed of the behaviour of different fluids in axles and transmissions. And, as a transaxle was not available at the time, conventional cars had to be used for the tests. One possibility was to install test fluids in the axles and transmissions of these cars and to observe their performance with increased mileage. But certain interaction effects that were likely to occur when the same fluid circulated around both components would go undetected. For example, there was some concern about the effect of particles of phosphate coating wearing off the hypoid gears and causing malfunctioning of the transmission. Conversely, oxidation effects in the transmission might have an adverse effect on the extreme-pressure quality of the lubricant.

A simple method for checking such interactions was to drain the axle and transmission at prescribed intervals, mix the fluid thoroughly, and put it back into the units again. An alternative approach that was tried was to fit an additional plumbing system into the car whereby fluid from the two units was automatically and continually mixed, but the draining and refilling procedure seemed better.

In spite of the difficulties with the plumbed cars, a considerable amount of information was obtained. For example, the presence of phosphate-coating particles apparently does not cause any trouble in the transmission. Also, it is possible to accumulate more than 20,000 miles without difficulty with a common fluid. The cars tested in this way were equipped with Dynaflow and Hydra-Matic transmissions.

The results of these tests, in which a car was subjected to more or less normal driving, were encouraging, and moved the development of transaxle fluid from the realms of speculation to those of possibility. It then became necessary to apply tests to account for the "normal severe abuse" to which a certain percentage of owners subject their cars. Fluids suitable for normal driving will often fail under such conditions, and a number of rigorous tests have been devised for gears and transmissions to discover them.

Thirty-two mineral-oil-base fluids were evaluated. Eleven passed the gear test schedule and only eleven passed the transmission schedules. Of these, three passed both tests but still have certain undesirable characteristics.

As some synthetic-base fluids have inherent properties that are only obtained in mineral-base fluids by the use of additives, a number of these were also tested, in spite of the fact that their price can range from £1 to £10 per gallon compared with about 6*s* a gallon for mineral-based fluid. Of the ten synthetic fluids evaluated only three passed the gear test and these had deficiencies in other properties such as viscosity at 210° F, oxidation resistance, and clutch plate compatibility. Only one of the fluids compares at all favourably with the mineral base oils, and it gave border-line results.

Full-Scale Collisions Head On

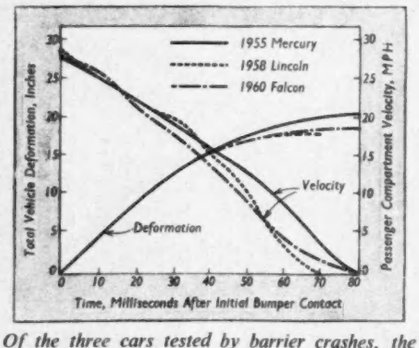
Full-scale tests have been made at the Ford Motor Company, Dearborn, Michigan, to compare the behaviour of unitised construction cars and body-chassis cars in head-on collisions. In particular, the company were anxious to check whether the Falcon compact car, of unitised construction, afforded its occupants a reasonable degree of protection in collisions. With this type of car, which by virtue of its shorter length places its occupants closer to the point of impact, it is important that violation of the more confined passenger compartment should be reduced as much as possible.

Three types of cars were used in the tests. They were towed at about 30 m.p.h. and allowed to run head-on into a rigid barrier of heavy logs embedded in sand and concrete. This type of collision proved to give reproducible results and enabled the effect of modifications in design to be determined. The work is described in a paper "Crash Studies of Modern Cars with Unitised Structure," by R. H. Fredericks and R. W. Connor, presented during the National West Coast Meeting of the Society of Automotive Engineers at San Francisco.

The cars used were a 1955 Mercury (body-chassis construction, 4,202 lb all-up), a 1958 Lincoln (unitised construction, 5,535 lb all-up), and a 1960 Falcon (unitised construction, 3,000 lb all-up). Each carried two anthropometric dummies, the "passenger" in each case being restrained by a seat belt. Accelerometers and strain gauges recorded the experiences of the dummies during the crash. In this way one of the largest and one of the smallest of modern unitised structures were compared with a representative body-chassis vehicle.

Though the Mercury was of 1955 vintage, it was modified to incorporate safety features such as a recessed-hub energy-absorbing steering wheel, double-grip door latches, instrument panel and sun visor padding, and seat track stops. In a crash of the violence studied, the absence of stops would mean that the seat would run forward off its tracks and pin the occupants against the front of the passenger compartment.

The structural integrity provided by the double-grip door latch design is also of considerable importance. The experiments clearly showed the need for the doors to remain closed to retain the structural integrity of the unitised vehicles, the doorlatch assuming great importance.



Of the three cars tested by barrier crashes, the Lincoln deformed least in overall length because of its stiffer structure.

The speed change during the collision and the progress of deformation are shown in the graph. It can be seen that the maximum deformation of the Mercury and Falcon occurred at the end of 80 millisec, whereas the Lincoln had come to rest in 70 millisec. The Mercury exhibited a greater overall deformation than either of the unitised-construction cars.

Overall deformation was less in the Lincoln than in the Falcon, the deformation extended for a greater length of the structure, some deformation occurring just forward and above the rear wheels. In the Falcon, all the deformation took place forward of the passenger compartment.

The peak deceleration reached by the Mercury was substantially higher than that recorded for the Lincoln or Falcon. Also the initial rate of onset of deceleration was higher for the body-chassis construction, resulting in a greater shock reaction in the structure. However, the peak deceleration in the Mercury was extremely short and as a result this sudden force was attenuated by the structure and did not react upon the occupants.

Records of the safety belt loads showed that in the early part of the deceleration period, above 30*g*, the loads in the Mercury and Lincoln were similar. The belt load in the Falcon crash peaked at just slightly more than half the level attained in the other cars but below 20*g*, after 60 millisec, the belt loading in the Falcon and Mercury were similar.

Special Article

Getting Research Over to the Builders

Builders do not have the same training as civil engineers nor do they have as many opportunities to adopt new methods.

By C. A. Hart, C.M.G., T.D., D.Sc.(Eng.), M.I.C.E., F.R.I.C.S.

IT IS often said by those engaged in building research that builders are slower to accept the results of their efforts than civil engineering contractors. To find the reason, the building industry must be examined as a whole.

In civil engineering the consultant and contractors engineer are both trained as civil engineers and exchange of ideas is helped by their common scientific and technical background. In building the structure and tasks of the industry are more diverse in size and character and the builder may be instructed by an architect, build directly on a commercial basis or by direct arrangement with a client. Architects and builders are trained quite separately and both to a much lower scientific and technological level than the civil engineer, and this naturally affects the rate at which the results of scientific research can be appreciated and applied. In building, and particularly in domestic building, clients often look for traditionalism, and are not easily steered away from ordinary bricks and mortar or even from styles like "Stockbrokers' Tudor."

RESTRICTIONS

About 50 per cent of the building work in this country is undertaken through small and family businesses. The application of new methods and techniques is limited by capital resources as well as by the problem of keeping abreast of new developments in a small organisation heavily preoccupied with day-to-day matters. The opportunities for mechanisation on the smaller jobs are limited and builders' order books are generally so varied that plant must be selected for its continuity of use on subsequent contracts.

Other handicaps to progress which can in no way be attributed to the builder, and which affect him to a greater extent than the civil engineer, are reluctance of some building societies and insurance companies to cater for properties of unconventional design; building bye-laws are often behind the times and preclude the use of new materials.

Civil engineering is usually undertaken by fairly large organisations engaged in building as well. Building contractors range from the very large firm to the small jobbing builder with only a few operatives, and of the latter particularly many have come up through craft channels and have little scientific background.

Where the projects are large enough for the employment of a team of experts, and where the client is concerned with securing an economic structure linked to modern requirements and an acceptable architectural design, there is a much greater opportunity for the use of new materials and new techniques than in smaller building works where the client does not have the benefit of consultant advice at the same technical level.

SEPARATION

In many countries the term "construction industry" covers both civil engineering and building; but here their industrial separation has some influence upon the receptivity of the building industry to the results of research. This separation arises because:—

(*a*) Building standard contract conditions are those agreed jointly between the Royal Institute of British Architects (RIBA), the Royal Institution of Chartered Surveyors (RICS) and the National Federation of Building Trade Employers (NFBTE); in civil engineering they are between the Institution of Civil Engineers (ICE), the Association of Consulting Engineers and the Federation of Civil Engineering Contractors (FCEC).

(*b*) Working Rule Agreements are between the NFBTE and the National Federation of Building Trade Operatives (NFBTO) in building and between the FCEC and the various trade unions in civil engineering, which include Building Trade Unions. These agreements, differing in some respects, cover such matters as rates of pay, hours, overtime, incentives, negotiations, conciliation and welfare.

(*c*) Building includes a higher proportion of building craftsmen than civil engineering where work in new skills and mechanical operations not covered by the existing building craft structure is paid for by specified additions to the basic labourer's rate.

DISSEMINATING INFORMATION

This industrial separation of building and civil engineering in this country deprives the ordinary builder of many of the benefits arising from the scientific and technological liaison existing between civil engineers and civil engineering contractors which is much closer than at present exists between architects, quantity surveyors and builders. Civil engineering by virtue of advances in engineering science and design is not so tied to tradition as building.

Technical and research information in construction comes from research bodies and development associations and on specific materials or fittings from the manufacturers or is available at Building Centres. We are fortunate in this country in having a first-class Building Research Station under the aegis of the Department for Scientific and Industrial Research where much valuable research has been and is being done. Studies have been made there recently with a view to seeing how its advisory and information services could be improved. This problem of technical information has also been under consideration separately and jointly by the RIBA, the RICS and NFBTE in consultation with the Ministry of Works. After a pilot survey of methods by which the extent of information reaching various levels in contracting firms could be assessed, the BRS now has a full survey in progress. This survey now ranges over the whole of the industry. In the Greater London area members of the London Master Builders Association have been especially fortunate in having had for some ten years past a Technical Information Service from the Ministry of Works by which have been available from this central source independent advisory leaflets, technical bulletins and individual advice.

For progress to result from research, technical information must be put over clearly and directly and its reliability proven not only to builders but also to architects, local authorities and the public. There is considerable benefit to be gained by the public as well as by the building industry by official service of technical information. Government departments, and especially the Ministry of Works, have shown what can be done by such a service, but that from the latter is in danger of closing down. The application of valuable research results can be more widely obtained at all levels by what might be termed an "operational appreciation" coming from a knowledgeable and completely independent source not directly concerned with the research investigations. This communication is much easier in civil engineering not only because of common training but also from the concept of research gained from experimental work by the civil engineer during training.

A unified technical information service of an independent character sponsored at least in part by official funds would inspire confidence in the public and throughout the building team and should be available on a national basis.

There is a growing volume of opinion among building employers of a pressing need for a reassessment of traditional skills and training. To secure the full cooperation of enlightened operatives, a training structure must be founded with clearly marked avenues of advancement. This would attract better material from the schools into the industry.

But for technical advancement in building, the professional education of architects, quantity surveyors and builders must be replanned. Generally where no engineering design is involved and the building is constructed through a client—architect—quantity surveyor—builder chain, even with consultation, the slender scientific background of the average architect, matched by that of the average builder, is not conducive to change of methods or techniques. The builder is hardly likely to take the initiative if he is eventually likely to be blamed in the event of failure or lack of durability. A building is a permanent feature and a fault is less easily put right and has more consequential effect than if arising say from a faulty machine part, with consequent simple replacement. Hence the necessity in building of being sure that innovations will stand the test of time. The basic difference of research receptivity between civil engineering and building is because, in civil engineering, civil engineer deals with civil engineer; in building, architect with builder.

If architects and builders in the future are educated to an appropriate scientific and technical level compared with civil engineers and also to some extent in common, and architects are required to have practical building experience before qualifying, then research appreciation and application in building will in time match that now existing in civil engineering. Eventually these higher standards are bound to be approached by the smaller builder also who will in time, if he is to survive, have to be trained in this way rather than from the purely craft angle.

While architects look at their position as designers and coordinaters in the industry, the Institute of Builders has introduced a new structure for their professional examination, but the scientific requirement is still small compared with civil engineering. The proposals for a combination of architectural and building training at the Regent Polytechnic are in the right direction, as is the establishment of a degree in building at Manchester. Surely, there is scope for a statesmanlike approach towards gaining academic respectability in our universities for building, building science, building technology or building engineering—call it what you will. An industry which retains, in addition to some 100,000 builders, about 4,000 quantity surveyors, 18,000 architects and 1¼ million operatives, with an annual capital expenditure of £2,000 million, should surely be permitted and encouraged to participate to the full in our higher educational system.

CONCLUSION

To sum up therefore it is true to say that builders and architects are slower to take full advantage of the results of research than civil engineers. The following, it is suggested, would go a long way towards closing the gap:

(*a*) Closer relationship between the civil engineering and building industries.

(*b*) Combined training of architects and builders with some specialisation as in engineering.

(*c*) A long-term plan for provision of a higher standard of basic scientific and technological education for both architects and builders and practical training for architects.

(*d*) Dissemination of simple, direct and trustworthy technical information including comparative research results from an official independent source, associated with but not linked directly with the industry or research.

Notes On The Writing Of Technical Books

For want of guidance on what publishers require, an engineer may encounter difficulties when he submits his first manuscript.

By Eric N. Simons

SOONER or later most young specialists engaged in engineering work contemplate the possibility of compiling for publication a book based on their knowledge and experience. As one whose 21st technical book may be published next year, it occurs to me that a few practical notes on book preparation and publication might prove useful to those with a volume in mind.

The first essential is to know what you are going to write about and why you wish to write it. If you are the world's authority on your subject, there will be little difficulty. However ill-planned, diffuse or ill-written your work may be, the probability is that the publishers will jump at it, and do for you what you ought to have done for yourself—make it readable and concise. Few of us are in this position, however, and our manuscripts will not be accepted unless they conform to the recognised standards.

First, having chosen your theme, you must decide whether you intend your book for (*a*) the specialist, as familiar with the subject as yourself; (*b*) the non-specialist engineer; (*c*) the layman. Until this is clear in your mind, it is better to wait, because it will materially affect the way in which you write the book, and the type of publisher who will be likely to accept it.

If you are writing for fellow-specialists, you may be as abstruse and technical as you like; and your publisher must be one with a reputation for producing authoritative and highly specialised books. If writing for the non-specialist engineer, you will have to realise that he will not be as familiar with the subject as yourself, and while appreciating his technical knowledge and experience in general, you may have to explain some of the more obscure terms and expressions, elucidate a number of difficult points, and avoid taking too much for granted. For a book of this type your publisher will probably be a house with a good reputation for high-class engineering and technical books, designed for a wider public than the more difficult specialist work.

If writing for the layman—and let no engineer turn up his nose at such attempts—you will have to reduce yourself to a careful step-by-step exposition of the subject, never assuming that what is ABC to you is ABC to your reader; avoiding jargon; explaining terms; and yet doing all this without the appearance of talking down or pomposity. There are a number of excellent publishers always willing to consider carefully written books of this kind, because there is a vast demand for simple textbooks and handbooks from students, engineers in other fields wanting quick guidance to a theme with which they are unfamiliar, the developing countries of Africa and Asia, and so on.

SCALE OF ROYALTIES

The money side of all this cannot be ignored. The specialised volume will probably sell no more than a few hundred copies, to libraries and research institutions; rival specialists usually borrow such books from their employers' libraries, or get their companies to buy them. The volume will probably be highly priced because of its limited appeal; and the author is likely to be disappointed if he imagines royalties flowing in to the extent of thousands or even hundreds of pounds. It can be safely said that rarely does the highly technical book repay the time and labour expended on it.

The less specialised, but still fairly technical, book will be published at a somewhat lower price—though this depends to a great extent on its size and the number and type of illustrations—and may sell a thousand copies or more if there is a demand for knowledge of the particular subject. But here again, the royalty will not be great because the larger number of readers will be offset by the lower price. There was a time when the strength of a technical handbook lay in the fact that it would go on selling for years; but this is less true today. The progress of research and technique is so swift that it is no exaggeration to say that in many, if not most, instances, a technical work is out of date before it is even published. (For example, I had just written the concluding chapters of a big book this month, when some new information came to light as a result of research which necessitated recasting an entire chapter.)

The real money-spinner—though it is never big money—is the simple guide to a difficult subject. When Dr. Edwin Gregory and I first published our *Structure of Steel—Simply Explained*, we were amazed at the scope and size of the demand. It seemed as if everywhere in the world people were thirsting to know about the inner mysteries of a bar of steel. For a book of this kind to succeed, it *must* be simple, and this is where, only too often, the engineer breaks down. He cannot envisage the kind of reader who honestly does not know what he is talking about when he writes of "elastic modulus" and "elongation per cent" and "dynamic hardness." Hence, it often pays to invite or accept the collaboration of a skilled writer, and such collaborations have almost always proved more successful than the unaided work of the non-literary expert.

WHAT TO INCLUDE

I shall now assume, since there is no space to give guidance in the writing of good English, that a neatly typed manuscript has been prepared, with a space between each line, all illustrations carefully indicated in the text—and explained, where necessary—and their figure numbers clearly marked. There should be a title page, giving, besides the title, the author's name and his qualifications; a list of contents; and usually a preface. The preface should give concisely, for the benefit of lazy reviewers and the publisher-to-be, a summary of why the book has been written, what it is about, and thanks to all who have helped in its compilation, as well as acknowledgments of sources from which information or photographs have been received. A bibliography at the end is always useful to the reader. There will have to be an index, but it need not be compiled until the page proofs are available, since only when they are received can the page numbers be quoted.

Now comes the task of finding a publisher. His own training and experience will often have suggested to the author what house publishes the type of book of which his is intended to be an example. His first step should be to write a letter outlining briefly the scope of his book, with a brief synopsis of the contents—chapter headings are usually sufficient. If he knows there is a demand for a book on the subject, and can give factual indications of it, it will help the publisher to decide. But before he does so, it may be as well for the author to visit his public library and ascertain if any recent books on the same theme have been issued, and if any of them emanate from the publishing house he intends to approach. This step is too often neglected by young authors, who find their manuscript returned to them, often without explanation, and imagine they have produced a worthless book, when all that is wrong is that they have been preceded in the field by another writer who has used the same publisher. Publishers have rivals, and many have their own markets, so that a book anticipated to some extent may still be accepted by another house, which believes it can sell the rival work.

The engineer new to book publication is often puzzled because it takes what seems an unconscionable time for a decision to reach him. Sometimes weeks elapse before even his letter of inquiry is finally answered. There are good reasons for this. A publisher is not himself necessarily an engineer, and rarely is he a specialist. He has, therefore, to take expert advice on (*a*) the chances of success for the book; (*b*) the suitability of the author; (*c*) the potential markets. He usually has a panel of experts whom he consults. These are often busy men of great repute, but even they need time to take soundings and weigh their words.

Finally, however, the engineer is told that his book has chances of success and his manuscript, if written, will be carefully considered. He sends it off, and again weeks elapse without more than a brief acknowledgment. This delay arises because the publisher has sent it to be read by his reader, or by one of his outside experts. It may well be that there is disagreement as to the value of the work, and more than one man may be asked for his opinion. All this takes time, because the readers are busy men with other manuscripts besides his to examine. But in the end his book may be accepted, subject to certain changes suggested by the experts.

Here the engineer must be careful. While it is usually good advice that is given to him, he must remember that he is writing as an authority, and sometimes, though not always, he is a greater authority than his publisher's reader. If he considers that his work will be in any way spoiled by the changes suggested, he must say so and abide by the result. (I had an instance some time ago when a reader rejected certain parts of a technical treatise because they did not conform to the theory of the subject. The fact remained that in the workshops this particular product was giving everywhere excellent results, which meant that the theory needed modification, not the text.) Nevertheless, it is much more likely that the advice given will be right.

A contract will now be issued for the engineer to sign, and here he must pay close attention. Once the contract has been signed, he cannot go back on it. He should never sign away his *copyright*. He should only sell book publication rights under the terms of the contract. It will be as well for him to have the contract read by a solicitor with some knowledge of publishing agreements, or by the Society of Authors, if he is a member. Most British publishing houses are honest, but even in the best agreement there are catches for the unwary.

PROOF CORRECTION COSTS MONEY

One such trap is proof corrections. Some engineer-writers are so fussy and faddy that when the proofs arrive, they make alteration after alteration, until the galleys that go back look like a printer's nightmare. The type from which books are printed is so much solid metal, and every correction means a great deal of manual labour which costs money. Most publishers insert a clause in their contracts to the effect that if more than a certain percentage of the cost of making corrections is incurred, the author must pay for the excess. By overlooking or ignoring this proviso, the engineer may receive not a handsome royalty cheque, but a hefty bill for excess corrections.

Care in reading the proofs is highly necessary, and it is better to correct galleys than page proofs—galleys are the long unpaged slips in which the proofs are first submitted. If words are deleted from page proofs, the effort should be made to fit in words to take an equivalent amount of space.

Many Pronged Attack

DIVERSITY of concept is assured by the future civilian programme of the United States Atomic Energy Commission, not only from the immense financial backing that it is receiving but also the board attack that the programme has in investigating a wide variety of reactor systems. It may be thought unrealistic to advance on such a wide front, but for nuclear power to become an economic rival of conventional power generating plants, the expenditure of such resources may be necessary.

Future Costs

An overall forecast of the cost level for research and development and prototype reactors has been prepared for the United States civilian reactor programme for the period 1961 to 1969. The list, tabulated below, shows expenditure in millions of dollars.

	R & D	Protypes No.	Protypes Amount	Total
Nuclear technology:				
General Research and Development (R&D)	450			
Supporting facilities	195			
Total nuclear technology	635			645
Reactor development—by concepts:				
Pressurised water	70	3	70	140
Boiling water	50	2	45	95
Nuclear superheat	50	1	30	80
Organic cooled	70	1	30	100
Subtotal light water and organic	240	7	175	415
Sodium cooled—fast	140	1	30	170
Sodium cooled—thermal	25	1	30	55
Gas cooled—enriched	100	1	30	130
Heavy water	55			55
Aqueous homogeneous—R & D	65	1	20	100
1. Reactor experiment	15			
New concepts—R & D	45	3	80	140
5 experimental reactors	15			
Subtotal—other concepts	460	7	190	650
Total—reactor development by concepts	700	14	365	1,065
Grand total	1,345	14	365	1,710

The final figure of $1,710,000,000 is the minimum cost to meet objectives of the programme and does not attempt to forecast distribution of this cost between Government and industry. Also it does not include the cost of projects currently authorised or cost of research and development, additional prototypes or full-scale plants which may be initiated by private industry. Distribution by concepts is a planning estimate, and the actual cost may be more or less for any particular concept; thus the annual cost may be higher or lower than the average of $200 million per year.

Research into New Concepts

In addition to the extensive civilian programme that the United States Atomic Energy Commission has on hand for the more commonly accepted types of reactor systems, the following reactor concepts are also being currently investigated.

Fused Salt: The fused-salt reactor is a fluid fuel design based on the use of a mixed salt solution of fissile and fertile materials, which is circulated from the reactor through an external heat exchanger. Potential advantages of this system are high thermal efficiency, low pressure, and simplified fuel reprocessing.

Fluidised bed: The fluidised-bed system employs a bed of fissile and fertile material which is maintained in a fluidised state under turbulent flow conditions. Organic material or water are considered as possible fluidisers and coolants. High power density and ease of charging and discharging fuel are potential advantages of this system.

Paste or Suspended Fuel: Similar to the fluidised bed concept, the paste or suspended-fuel reactor differs only in that the bed is maintained in a laminer, non turbulent condition, and is internally cooled by a separate coolant. Many of the potential advantages of the fluidised bed are retained. In addition, because of the non-turbulence, particle attrition is reduced and reactor control may prove to be easier.

Supercritical Water Cooled: A reactor based upon the supercritical water-cooled concept would operate at extremely high pressure, avoiding the phase change of water associated with boiling, yet permitting the generation of superheated steam external to the reactor. High thermal cycle efficiency is the potential advantage of this system.

Slurry: A fluid fuel system in which the particle size of the fissile or fertile material is so small that it forms a suspension under operating conditions is known as a slurry reactor. The reactor may be cooled externally or internally. The carrier fluids undergoing most active investigation are water and liquid metals. The potential advantages of this concept are similar to those cited for other fluid fuel reactors.

Advanced Epithermal: A compromise design between sodium-cooled fast reactors and sodium-cooled thermal reactors may have advantages over either, particularly for the thorium fuel cycle. The advanced epithermal design would include some moderation by graphite or beryllium, optimised for high conversion ratio with uranium 233 fuel consistent with economic promise. High thermal efficiency and low pressure characteristics of a sodium-cooled system would be retained.

Pebble-Bed Gas Cooled: In the gas-cooled pebble-bed concept a stationary bed of balls (or pebbles) containing the fissile, fertile, and moderator materials is cooled by a gas. Potential advantages are in the area of low fuel-cycle costs, and high thermal efficiency.

Solid-Moderated Steam-Cooled Reactor: Heat from the fuel is radiated to the moderator (graphite, beryllium oxide, zirconium hydride, etc.) which in turn is cooled by water or steam in the solid-moderated steam-cooled reactor. High thermal efficiency is the main potential advantage.

Alternate-Coolant Fast Reactor: A system similar to the sodium-cooled fast reactor except that alternate coolants are being considered including mercury, lead, lithium, sulphur, and other materials is known as the alternate-coolant reactor. It is believed that with certain of the alternate coolants increased efficiency and reduced costs may be attainable.

Civilian Reactor Costs

The last five quarterly surveys of costs for civilian nuclear reactor projects currently under active design or construction in the United States are given below. The figures include costs for research and development, purchase of land, plant and equipment, fuel fabrication, training, and the waiver of charges for the use of fuel.

Quarter ended	Costs incurred ($ millions)
30 June, 1959	47·2
30 September, 1959	43·6
31 December, 1959	60·3
31 March, 1960	51·2
30 June, 1960	59·5
Total for 15 months	261·8

The USAEC have also published a 23 page pamphlet entitled "Nuclear Reactors Built, Building or Planned in the United States as of June 30, 1960" (TID-8200 (2nd Rev.)). All the power, propulsion, production, research and test reactors, including those for export, are listed.

Notes and News

Swedish Finance

An increase by 24,300,000 Sw. Cr making a total of 143,800,000 Sw.Cr has been requested by AB Atomenergie of Sweden for the financial year 1960-61 plus the right to take orders for 20,000,000 Sw. Cr. The increase allows for the anticipated rise of 15 per cent in the company's tunning expenses, and reactors will be operating, more intensively and the research programme will be extended. The expected reduction in the cost of producing power by atomic energy in the next 10 to 15 years gives good prospects for this form of power in the 1970-80 decade.

Emphasis Still on Heavy Water

The Swedish atomic energy programme continues to aim at reducing its dependence on imported fuel, so the main activity is directed towards the natural-uranium and heavy-water system, since both of these materials can be produced in the country. Although the heavy-water moderated reactor system is the main target for the company's efforts; other methods being tested are the boiling heavy-water reactor with a direct cycle and a homogeneous cored reactor.

Fuel Production

The production and testing of plutonium and its use in fast reactors is also under study with participation from the OEEC Company Eurochemic and the Norwegian Institute for Atomic Energy. The processing plant at Kvarnstorp is producing fuel elements for the R0 and R3 and the Halden project and the plant will supply all the Swedish needs for the future planned reactors.

IAEA's Fourth Session

The main points of the fourth session of the International Atomic Energy Agency may be briefly summarised as follows:

Two new countries became members of the Agency—Chile and Ghana; this makes the total 72. Three other countries were approved for membership—Columbia and the two African states Mali and Senogal.

In his opening speech the Director General, Mr. Sterling Cole, gave a review of the activities of the Agency and appealed for an increase in the turnover to the Agency of uranium 235 from the weapon stock piles of the various countries. This he said would not only increase the financial assets of the Agency which were very hard pressed, but also be a positive peaceful gesture. He said that within the period of its existence the Agency had sent 30 missions to different less developed countries to give advice on nuclear problems; and in the past year nine scientific meetings had been held at which 2,000 scientists had attended from 41 different countries.

Professor Nadjakov, Director of the Institute of Physics and Vice-President of the Bulgarian Academy of Sciences, was elected unanimously as President of the Agency.

Budget Approved

The member states announced pledges totalling approximately $1,000,000 in voluntary contributions to the Agency's General Fund. In addition the United States gave a further $50,000 worth of nuclear materials. The General Conference also approved for the following year a regular budget of $6,186,000, an operational programme of $1,800,000 and a working capital fund of $2,000,000.

Much criticism was produced by the members of the Eastern block at the General Conference approving the 15 powers resolution on safeguards against diversion of Agency assistance to military purposes. Mr. V. M. Molotov, speaking for the USSR, said that his government's attitude was that the only effective safe-guard would be if nuclear weapons were banned, their production stopped and the nuclear stockpiles destroyed. It would seem unfortunate if the IAEA platform should become a political springboard.

US Bilateral Agreements

The most recent figures of the United States supplies made under bilaterial agreements were given at the conference:

764·3 kg of enriched uranium 235 have actually

been delivered and there are further requisitions for an additional 310·4 kg to be delivered in the near future (534 kg of the amount delivered being for 43 experimental, test or power reactors). In addition 1·2 kg of plutonium, 35·7 gm of uranium 233, and 346 tons of heavy water have been delivered. Since 1949 there has been 13,386 shipments of isotopes, including 5,000 for the less developed countries. Under bilateral agreements, 23 test or research reactors are now operating and 26 more are planned or under construction. Finally, 2,900 scientists have been trained in USAEC facilities of which over 1,200 came from the less developed countries.

Inspection of Four US Reactors

The United States offered to place four of its reactor facilities under the safeguards system of the IAEA. The reactors are the Graphite Research Reactor and the Medical Research Reactor, both at the Brookhaven National Laboratory; the Experimental Boiling Water Reactor at the Argonne National Laboratory; and the Piqua Organic Cooled and Moderated Power Reactor. Mr. J. McCone, head of the United States delegation and chairman of the USAEC, said that the offer was made to demonstrate the workability of Agency safeguards and to provide facilities in which the safeguards inspection methods and techniques could be tested and improved.

Recent Activities

Further missions to be sent out since the fourth session include the following countries: Mexico, El Salvador, Guatemala, Peru and Paraguay. A request by the Government of the Philippines to send a mission to Manila will also be receiving attention, and finally the report of the study made in Finland in conjunction with the Finnish experts is expected to be published shortly.

Towards Criticality at Bradwell

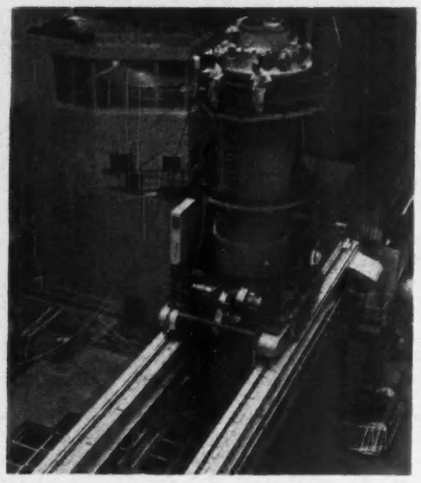
Delivery of fuel by road for the Bradwell reactor began recently. The first 150 MW reactor is planned to go critical in June of next year and the second reactor should follow in the early part of 1962. The two charge discharge machines in the first reactor have now been installed. One will be used for operation and the second as standby. The illustration shows a machine over the reactor face. Each machine is 52 ft high and weighs 400 tons. The charge machine in use travels on a steel gantry which spans the reactor pile cap area and itself runs on rails at pile-cap level. There are two main types of standpipe—those for fuel charging and those for control and each pipe serves 34 channels in the reactor core and is normally sealed by a shield plug and a pressure tight valve. An operating floor of thick steel and concrete shielding slabs is supported from the pile cap.

Charging Procedure

The slab above the standpipe is removed and a special slab and telescopic makeup shielding piece substituted. A pressure seal is made by lowering a chute headbox on to the top of the standpipe, and the purged charge machine is then aligned over the hole using optical instruments at the base of the machine. A pressure seal is made by raising the telescopic connector on the chute headbox to mate with the machine outlet and a radiation seal is formed by raising the telescopic piece of the make-up shield to interlock with the lower shielding on the machine. After the interspace has been purged and pressurised the machine can carry out all the operations involved in unplugging the standpipe, charging fuel in three reactor channels and replugging the standpipe while the reactor is on load. The machine may be controlled remotely by an operator in a shielded room or from a platform at the base of the machine.

Servicing Spent Fuel

Irradiated elements are removed from the machine through the unloading hole and tube to a skip resting on an underwater carriage in a duct leading to the cooling pond. Shielded by 12 ft of water, a winch pulls the carriage towards the pool where a crane carries the fuel skips under water to various sections of the pond. After being stored in the pond for a decay period, a skip of irradiated fuel is taken to a coffin bay. The skip of irradiated fuel is then



Charge-discharge machine installed at Bradwell. The remote control room is on the left, but provision is made to operate the machine from the bottom platform.

placed in a coffin and taken to the decontamination bay. When it has been cleaned the coffin is transported to the separation plant.

Nuclear Propulsion for Germany

The West German Government has recently announced that it is to spend 70 million marks on a development programme within the next five years for the construction of a nuclear powered ship. The Government has declared that it will meet 60 per cent of the cost after the anticipated contribution from Euratom has been received; the remainder will be contributed by the four West German coastal states. Specifications have been sent out to eleven shipyards and are to be returned by January of next year with the aim of building the ship by 1964. The hull will be of double thickness around the reactor compartment: the inner skin will be 2½ metres from the outer skin with vertical members placed between the two for strengthening in the event of a collision. Full precautions are to be incorporated in the design for the elimination of any irradiation hazard and among the crew of 95 there will be a radiation officer. The reactor is to be of the organic-moderated design which has been developed jointly by the German firm Demag AG and Atomic International (North American Aviation Inc.).

CEGB Produces Isotopes

The CEGB's large reactor facilities provide ideal means for radioactive isotope production, but the 1957 Electricity Act prevents the board from producing any such material except for their own use. The object of the Electricity (Amendment) Bill which is to come before this session of Parliament is to remove the present restriction. With the gradual expansion of the Generating Board's nuclear programme, it could become a large producer of radioisotopes.

All Clear for Queen Mary College

Queen Mary College is the first college to receive approval for the installation of a research reactor. Mr. R. Wood, the Minister of Power, said in the House of Commons last week that the Nuclear Safety Advisory Committee had advised him that so long as the site, housing design, and operation of low-power research reactors in the range of 10 to 100 kW satisfy certain basic conditions they may be safely permitted in built-up areas. The Chief Inspector of Nuclear Installations has agreed that the Queen Mary College site at West Ham satisfies the necessary conditions. A licence for the operation of the reactor will be granted by the Minister and will impose fairly detailed operational conditions, departure from which will require the Minister's prior approval. Also there will be stringent conditions relating to the control and supervision by properly qualified staff. The reactor to be built at West Ham is a Jason Mark III (Atomic Review, 28 Oct. '60) to be supplied by the Hawker Siddeley Nuclear Power Company. London Hospital are negotiating with Queen Mary College with a view to deriving full benefit from having an irradiating facility so close to their premises.

Reactor Notes

Chalk River: The graphite reflector for the ZED2 reactor has now been completed. The tolerances on the machining of the graphite had to be kept to within 0·01 in, but the Graviner Manufacturing Company have been able to keep within 0·005 in after developing a special boring machine for the purpose. ZED2 is a low-power experimental reactor intended for testing different arrangements of fuel rods by remote control and for determining the characteristics of various lattices for large power reactors.

College Experiments: Pensacola Junior College in Florida will become the first American junior college to instal a subcritical nuclear reactor plant. The source will be of 20 per cent enriched uranium 235. The reactor core is 10 in diameter and 14 in long with reflector thicknesses varying from 3 to 10 in; there are two reflectors, one of polythene and the other of graphite. The reactor is built by the Lockheed Nuclear Products of Atlanta.

USSR Power Station: The reactor casing is now being assembled at the Beloyarsk Nuclear Power Station in the Urals, USSR. The casing is 10 m high and 9 m diameter. There are 998 channels in the active zone. The plant, named after the recently deceased academician Igor Kurchatov, will be rated at 200 MW. Another station having a double reactor system is to be built at Ulyanovsk rated at 250 MW.

Atomic Submarine Components: The United States Navy awarded a cost-plus fixed-fee contract of $36,047,000 to the Westinghouse Electric Corporation, Pennsylvania, for the design, development and production of reactor vessels, control rod drive mechanisms, main coolant pumps and valves, and steam generator for fleet ballistic missile submarines.

Austria Receives Cheque: The United States has presented $350,000 upon the completion of the Seibersdorf reactor project for the Austrian Study Group of Atomic Energy. The research reactor is a 5 MW tank-type light-water cooled and moderated heterogeneous reactor using solid fuel. The power rating may later be raised to 12 MW. The project is costing a total of $5,000,000 and the design and manufacture and construction is by AMF Atomics, Incorporated.

. . . *And Yugoslavia:* A $350,000 grant is also being made to Yugoslavia which will finance the construction of a TRIGA Mark II reactor and assist in supplying equipment for the Yugoslav Federal Commission for Nuclear Energy for the " hot laboratory " at the Boris Kidric Institute.

Indian Tenders: India has sent out requests at an international level for tenders for a 300 MW station to be built near Tarapur in the State of Maharashtra, 62 miles north of Bombay. The station, which will be India's first nuclear power station, is to have two reactors of equal rating and the tenders are to be submitted within about seven months. Emphasis is laid on the necessity to keep the foreign exchange to a minimum and the need for India to produce as much of the material as possible.

TRANSISTOR ENGINEERS

are required by

ENGLISH ELECTRIC

BRADFORD

for work in the design office on the applications of transistors to aircraft electrical power systems. (Applicants must be of degree or H.N.C. standard.) Previous experience on related work is essential—men with experience on semi-conductor devices, control systems, G.W. systems, either in industry or the Services will be considered. Prospects for advancement are good. Housing assistance may be offered in certain cases.

Please write in confidence to Dept. G.P.S., English Electric House, Strand, London, W.C.2, giving full details of qualifications and experience and quoting reference E 206A.

D 358

'Engineering' Appointments Section

PUBLIC APPOINTMENTS

STATION ENGINEERS (G.D. & MECH.)

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and Ministry of Aviation Stations. The work of Station Engineers (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineers (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Candidates must hold O.N.C. or Mech./City and Guilds Electrical Technician's Certificate/2nd Class M.O.T. Certificate or equivalent and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience.

Commencing salary dependent upon age, qualifications and experience and ranges from £770 to £875 rising by annual increments to £925. Opportunities for promotion up to Tech. Grade A, maximum salary £1680 (National rate). Pension prospects. Five-day week. 18 days paid leave a year initially. Internal training courses provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applicants, who must be natural born British subjects, up to age 55, should write stating age, qualifications and experience to MANAGER (P.E.1), PROFESSIONAL AND EXECUTIVE REGISTER, MINISTRY OF LABOUR, ATLANTIC HOUSE, FARRINGDON STREET, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 892

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

AIR MINISTRY require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEER for design construction and maintenance of installations on airfields, radar stations, missile bases, workshop and maintenance units for the R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to max. £1260 with increase for London and slight decrease for country districts. Appointments long term with promotion and pension prospects. Five-day week with 4 weeks 2 days leave a year initially. Special allowances payable in addition to salary during overseas service.

Minimum qualifications and experience:—

(i) (*a*) University degree or equiv. diploma in electrical and/or mechanical engineering with at least 2 years apprenticeship; or

(*b*) Graduate or corporate member of I.E.E. with at least 3 years apprenticeship; or

(*c*) Graduate or corporate member of I.Mech.E. appreciable electrical engineering experience with at least 3 years apprenticeship; and

(ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45.

Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.158/OA. G 897

THE UNIVERSITY OF LEEDS

CHAIR OF FLUID MECHANICS

Applications are invited for appointment to the Chair of Fluid Mechanics, within the DEPARTMENT OF MECHANICAL ENGINEERING at a Salary not less than £2700 a year. The holder of the Chair will be responsible for the teaching of fluid mechanics to engineering students and for the development of research. Preference will be given to candidates who are at present engaged in industry or in research establishments. The department of mechanical engineering will shortly move into a new building and the professor will be able to take part in the planning of a new Fluid Mechanics Laboratory. Applications (sixteen copies) stating date of birth, qualifications and experience, together with the names of three referees, should reach the REGISTRAR, THE UNIVERSITY, LEEDS, 2 (from whom further particulars may be obtained), not later than 14th DECEMBER, 1960; candidates overseas may apply in the first instance by cable, naming three referees, preferably in the United Kingdom.

D 355

THE CORPORATION OF THE CITY OF GLASGOW

WATER DEPARTMENT

APPOINTMENT OF GENERAL MANAGER

The Corporation invite applications for the appointment of GENERAL MANAGER of the CORPORATION WATER DEPARTMENT.

The salary for the appointment is £3780 per annum, rising to £4095 per annum by increments of £63 per annum. The person appointed will be responsible for the whole administration, supervision and control of the Department. The appointment is subject to the provisions of the Corporation's Superannuation Scheme and the successful candidate will require to pass a medical examination.

Applicants must be under 55 years of age at 1st November, 1960, except as regards employees of the Corporation.

Applications stating date of birth and full particulars of qualifications and experience, with names and addresses of three referees, to be lodged with me in an envelope endorsed "APPOINTMENT OF GENERAL MANAGER, WATER DEPARTMENT," not later than 1st DECEMBER, 1960.

ALEXANDER ROOKE,
TOWN CLERK.

CITY CHAMBERS, GLASGOW. D 334

AIR MINISTRY

AIR MINISTRY, Works Design Branch, requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—

(*a*) Roads, pavements, earthworks and storm-water drainage; (*b*) Foul drainage and sewage disposal; (*c*) Water supply distribution. Some site experience and possession of recognised technical qualifications an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 3746), to AIR MINISTRY, W.G.d, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 895

RESEARCH FELLOWSHIPS

(3 years) in

GOVERNMENT SCIENTIFIC ESTABLISHMENTS

Value £1275-£1575 p.a. (Senior) and £875-£1175 p.a. (Junior). A very wide range of topics, especially in the PHYSICAL SCIENCES; also several vacancies in various branches of BIOLOGY. Qualifications: normally first or second class honours degree; evidence of high standard of ability in research; and at least 2 years' post-graduate research experience (3 years for Senior Fellowships). No age limits. F.S.S.U.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/2660/60. D 369

WHESSOE

WHESSOE LIMITED REQUIRE

THREE YOUNG ENGINEERS

in the fast-expanding light products section of the Engineering Division. They should be university graduates, or have equivalent Institution exemption, and should be under 30 with at least one year's industrial experience, preferably in light engineering.

Mechanical Engineer
for design and development work, with some knowledge and experience of shop production methods in light engineering. *Reference 55/60*

Chemical Engineer
with mechanical leanings, or Mechanical Engineer, for contract work including customer contact, for which an orderly mind, an acceptable personality, and some business flair are important. *Reference 56/60*

Electrical Engineer
with a bias towards instruments and electronics with some knowledge of transistors and associated circuitry. *Reference 57/60*

These are permanent positions with rapidly expanding prospects, with three weeks holiday over 25, and generous pension and life cover; removal expenses will be defrayed and help with housing may be given. The Company's main works are in the pleasant town of Darlington which is surrounded by most attractive countryside.

Write giving full details to: The Staff Officer, Whessoe Limited, DARLINGTON, quoting the Reference number and mentioning this paper.

D 330

DIRECTOR

A large Engineering Group, comprising several companies, is seeking a Director to be responsible to the Chairman for the implementation of policy and the general direction of the Group's Development and Design effort.

This Directorship demands a man of the highest calibre, age 35-50, with:

1. Considerable practical experience of light mechanical and ancillary engineering products.
2. The ability to promote and evaluate new ideas.
3. The energy, drive and tact to get things done.

Commencing salary of £5000-£6000 per annum with considerate superannuation and other attractive benefits.

Candidates should write, in confidence, stating experience, qualifications, education, age and recent earnings to BOX D 380, Offices of ENGINEERING.

WORKS ENGINEERING

Applications are invited for the following posts:—

SERVICES ENGINEER

Duties involve the selection of process plants (steam, vacuum, hydraulic) and design of associated piped service systems.

Some experience of this work is necessary together with technical qualification to H.N.C. Mechanical level.

ASSISTANT ENGINEER

Duties involve design and specification work related to maintenance and modification of existing plant and factory services.

A good general mechanical engineering background is necessary and a technical qualification to minimum O.N.C. Mech. level.

DESIGNER/DRAUGHTSMAN

Duties involve draughting and some design on a wide range of plant and factory layout work.

Good experience in this field is required together with a technical qualification to minimum O.N.C. Mech. level.

The Works Engineering department is concerned with a wide and interesting range of process plant, machines and general services and offers good career prospects in an expanding organisation employing 1,500 people.

If you are interested in this field of work please apply, giving details of age, experience, qualifications and current salary to:—

Personnel Manager :

THE MICANITE & INSULATORS CO. LTD.

Empire Works, Blackhorse Lane, Walthamstow, London, E.17

D 365

ASSISTANT CHIEF DESIGNER

for

J. C. Bamford (Excavators) Limited

a medium-sized Company situated in attractive surroundings near Uttoxeter. This is a new appointment arising from rapid expansion of the Company and there are clear prospects of promotion in the future. Initial salary will be according to qualifications and experience.

The Assistant Chief Designer, who will be directly responsible to the Chief Designer, will have complete technical and operational control over the Drawing Office. The Drawing Office staff numbers approximately nine and will increase by at least 50 per cent. during the next twelve months. The Assistant Chief Designer's main function will be to plan and control their work; in addition he will supervise the Prototype Department in the absence of the Chief Designer.

The main qualifications are an engineering apprenticeship, at least eight years close technical experience on the drawing board in design for production relating to hydraulics, transmissions, suspensions, tyres and fabrications, at least three years at Section Leader level and a personal knowledge of the suppliers of components. Preferred age 30/40.

Please write briefly in first instance, quoting Reference No. 863, to:

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidate's permission.

D 341

ADMIRALTY—NAVY WORKS DEPT.

ELECTRICAL & MECHANICAL ENGINEERING DRAUGHTSMEN

Vacancies exist in Navy Works Department Drawing Offices as shown below and occur at Establishments elsewhere in United Kingdom from time to time.

The posts are non-pensionable but there will be opportunities for transfer to the Established staff.

Applicants must be competent Draughtsmen and experienced in one or more of the following types of work:—

Electrical (vacancies at Pinner (Middx.), Portland and Devonport).

(*a*) Preparation of specifications, drawings and schedules for electrical equipment. Précis of firms' tenders.
(*b*) Electrical installations in domestic and industrial buildings.
(*c*) Cable installations, switchgear, etc.
(*d*) Airfield lighting.

Mechanical (vacancies at Pinner (Middx.), Portsmouth, Portland, Liverpool, Rosyth, London).

(*a*) Preparation of specifications, drawings, schedules and précis of firms' tenders.
(*b*) District heating, including boiler installations, heating and air conditioning of domestic and specialist buildings.
(*c*) Layouts of engineering installations and workshop machinery.
(*d*) All classes of lifting appliances, pumping installations, test plants, cooking equipment, etc.

Possession of O.N.C. or similar qualification will be an advantage. Consideration will be given to successful candidates being granted assistance to obtain technical qualifications.

Salary (Men): National Rate—subject to slight variation dependent on location: starting from £580 (at age 21) to £870 (28 and over): maximum of scale—£955 p.a. (National Rate).

Opportunities occur for promotion to Leading grade—salary maximum £1115 p.a. (National Rate).

Five-day week: annual leave 18 days rising to 22 after 10 years.

Candidates, who must be British subjects, are invited to apply in writing, giving details of qualifications and experience to Director General, Navy Works, Admiralty, Chamberlain Way, Pinner, Middlesex.

D 313

SCOTTISH HOME DEPARTMENT

ROAD ENGINEERS

Applications are invited for posts of Engineering Assistant Grade II on the staff of the Chief Road Engineers (Scotland) based on Edinburgh, Oban and Inverness.

Candidates should be men, preferably over 26, who have served an apprenticeship or equivalent period of training with at least five years' subsequent experience, e.g. with a civil engineering contractor, local highway authority or consulting engineers. They should hold O.N.C. or comparable qualification. H.N.C. an advantage.

Salary £950 rising to £1085 less £25 to £30 meantime for Oban and Inverness. Unpensionable at first but opportunity to gain pensionable post.

Applications, with details of qualifications, experience and age to:
ESTABLISHMENT OFFICER,
SCOTTISH HOME DEPARTMENT,
ROOM 364, ST. ANDREWS' HOUSE,
EDINBURGH, 1,
by 29th NOVEMBER, 1960. D 342

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE, WANDSWORTH HIGH STREET, S.W.18

Required JANUARY, 1961, ASSISTANT GRADE "B" plus £120 Special Allowance to teach Production Engineering subjects to H.N.C. and Final C. & G. Level and to be responsible for organising the Engineering Workshops with special reference to Machine Tools.

Graduate or equivalent qualifications, Industrial and Teaching experience desirable. Salary: £700 by £27 10s. to £1150 plus £120 allowance plus London Allowance and additions for qualifications and training.

Increments within scale for approved experience.

Application forms from SECRETARY, quoting (FE.3/E/2777/11), returnable by 18th NOVEMBER. D 348

MINISTRY OF AVIATION

MINISTRY OF AVIATION require RADIOGRAPHER at BIRTLEY, CO. DURHAM, for the X-RADIOGRAPHY of a variety of welded and brazed joints, and of castings. Quals.: Recognised eng. apprenticeship or equiv. training. Sound knowledge and practical exp. of X-radiography as applied to metal, to metal joints and to castings, including the formulation and application of the necessary techniques, and the interpretation of the results. Some knowledge of radiation protection and safety precautions is desirable. Salary: £825 (age 28) to £925.—Application forms from MANAGER (PE.3304), MINISTRY OF LABOUR, PROFESSIONAL AND EXECUTIVE REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. D 370

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

Honours graduates in Engineering interested in gas flow in internal combustion engines are invited to apply for appointment as SENIOR RESEARCH ASSISTANT. Salary scale £1050 by £50 to £1400, with superannuation and family allowance, initial salary according to qualifications and experience.—Conditions of Appointment and Form of Application which should be returned by 3rd DECEMBER, 1960, from the REGISTRAR. D 362

SURREY EDUCATION COMMITTEE

GUILDFORD COUNTY TECHNICAL COLLEGE

STOKE PARK, GUILDFORD

Required 1st January, 1961:—
ASSISTANT TEACHER for Mechanical Engineering, O.N.C. and C. and G. courses. Salary: Burnham Technical Scale Grade B, £700-£1150 p.a., with allowances for approved experience, qualifications and training.

S.A.E. to Principal for further particulars and application form to be returned as soon as possible. D 350

UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER or ASSISTANT LECTURER in MECHANICAL ENGINEERING. Candidates should have experience in the fields of Theory of Elasticity, Plasticity or related fields. Salary Scales: Lecturer, £1050 by £50 to £1400 by £75 to £1,850 with an efficiency bar at £1475. Assistant Lecturer, £800 by £50 to £950. The initial salary will depend on qualifications and experience. Further particulars should be obtained from the SECRETARY AND REGISTRAR to whom applications (7 copies from United Kingdom applicants) should be sent not later than 20th NOVEMBER, 1960. D 346

NATIONAL COAL BOARD—

NORTH EASTERN DIVISION

CIVIL ENGINEERING ASSISTANT REQUIRED in CASTLEFORD, YORKSHIRE, Area. Salary, £825-£1275 per annum.

Candidates should have experience in the design and construction of industrial works in reinforced concrete/structural steel or general civil engineering works including roads, railways and drainage; have passed Sections I and II of the Institution of Civil Engineers' Associate Membership Examinations or possess an equivalent qualification. Experience in the preparation of Specifications and Bills of Quantities an advantage.

Apply to AREA STAFF MANAGER, NO. 8 (CASTLEFORD) AREA, ALLERTON BYWATER, CASTLEFORD, by 12th NOVEMBER. D 336

ENGINEER III

MINISTRY OF AVIATION requires ENGINEER III at ROYAL RADAR ESTABLISHMENT, MALVERN, responsible for investigation in fields of machining techniques, pressure hobbing using hot and cold flow techniques, and special processes mainly concerned with production of experimental equipment. Quals.: Engineering apprenticeship and Corporate Membership of Electrical or Mechanical Engineers or equivalent quals. Experience in instrument or precision light engineering for development and research workshops. £780 (age 25)-£1220 p.a. (provincial male). Commencing salary at age 34 or over £1065. Not Established but opportunities to compete for establishment may arise.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C836/OA. D 367

DRAUGHTSMEN

MECHANICAL, ELECTRICAL AND HEATING AND VENTILATING ENGINEERING DRAUGHTSMEN. Pensionable posts for men and women aged at least 20 on 1.6.60 with at least 3 years' training, including adequate practical experience with appropriate technical study. Appropriate O.N.C. is essential, and at least one year must have been spent in full-time drawing office work. Salary (men, London) £557 10s. (20) to £895 (28 or over). Scale maximum £980. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/68-69/60. Closing date 31st DECEMBER, 1960. D 368

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

RIO TINTO EDUCATIONAL TRUST AWARDS tenable at the ROYAL SCHOOL OF MINES in OCTOBER, 1961:—

RIO TINTO RESEARCH BURSARY—£550-£850 p.a. (according to qualifications and experience), out of which fees must be paid, normally for two years for research connected with mineral exploration, mining, mineral dressing or extraction metallurgy. Candidates must hold an appropriate honours degree.

RIO TINTO ADVANCED COURSE BURSARIES —£475-£675 (according to qualifications and experience), out of which fees must be paid, for a post-graduate diploma course of one session in Applied Geophysics, Mineral Exploration, Mineral Dressing or Mining. Candidates must hold an appropriate first degree.

Further particulars, and application forms (to be returned by 31st March, 1961) obtainable from the REGISTRAR, IMPERIAL COLLEGE, SOUTH KENSINGTON, S.W.7. D 357

THE QUEEN'S UNIVERSITY OF BELFAST

THE SENATE OF THE QUEEN'S UNIVERSITY OF BELFAST invites applications for a LECTURESHIP in MECHANICAL ENGINEERING from 1st JANUARY, 1961 or such other date as may be arranged. Preference will be given to candidates who are interested in Strength of Materials. Salary range, £1050 to £1850 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience.

Applications should be received by 30th NOVEMBER, 1960.

Further particulars may be obtained from G. R. COWIE, M.A., LL.B., J.P., SECRETARY. D 317

STRUCTURAL ENGINEERING DESIGN DRAUGHTSMEN

AIR MINISTRY, Works Design Branch, requires in LONDON STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 3745), to AIR MINISTRY, W.G.d, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 894

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF MECHANICAL ENGINEERING UNIVERSITY ENGINEERING RESEARCH

Applications are invited from GRADUATES in some branch of engineering, metallurgy or physics who have had some industrial or research experience, to RESEARCH SCHOLARSHIPS in the following fields:

ADVANCED METAL FORMING PROCESSES (two scholarships).
AUTOMOBILE ENGINEERING (one scholarship).
VIBRATIONS OF GRINDING MACHINES (one scholarship).

These scholarships have been established by several industrial firms who are also supporting the actual investigations. Their value will be in the range of £500-£1100 per annum. Successful applicants will be allowed to register for a higher degree, usually a Ph.D. in the case of good Honours graduates.

Applications should be addressed to the PROFESSOR OF MECHANICAL ENGINEERING, THE UNIVERSITY, BIRMINGHAM, 15. D 375

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF MECHANICAL ENGINEERING UNIVERSITY ENGINEERING RESEARCH

Applications are invited for two vacancies for ASSISTANT RESEARCH ENGINEERS to work on newly-instituted investigations into advanced metal forming processes.

Qualifications required: Higher National Certificate or similar qualification, with plenty of drive and initiative. Experience in metal extrusion desirable but not necessary.

Salary in the range of £750 to £1000 per annum, according to experience.

Apply in writing to the PROFESSOR OF MECHANICAL ENGINEERING, THE UNIVERSITY, EDGBASTON, BIRMINGHAM, 15. D 374

CITY AND COUNTY OF BRISTOL EDUCATION COMMITTEE BRISTOL TECHNICAL COLLEGE

ASHLEY DOWN, BRISTOL, 7.

(2nd Advertisement)

The Governors invite applications from suitably qualified and experienced persons for appointment to the teaching staff as ASSISTANT GRADE B.

The duties mainly comprise the teaching of WORKSHOP TECHNOLOGY AND PRACTICE to students following National Certificate of City and Guilds of London courses. Ability to assist with associated Science Calculations and Drawing, an asset.

SALARY: Burnham Technical Scale, 1959, £700-£1150 p.a. (with additions for training and graduate or equivalent qualification). Placing on scale determined by previous approved industrial or teaching experience.

A suitably experienced applicant may qualify for an allowance of £120 additional to above scale.

Details and application forms from the REGISTRAR, quoting reference "BTC 60/2," to be returned as soon as possible. D 382

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the appointment of a LECTURER with interests in one or more of the following fields:

PLASTICITY AND METAL FORMING
MACHINE TOOLS AND METAL CUTTING
VIBRATION

Applicants should have marked ability at conducting and supervising research in their field of interest, and an Honours degree in some field of Engineering, Physics or Mathematics.

The salary scale will be £1050 by £50 to £1400 by £75 to £1550; £1550 by £75 to £1850. The appointment will carry family allowance and F.S.S.U. benefits and the initial salary will be related to qualifications and experience.

Further particulars may be obtained from the REGISTRAR, THE UNIVERSITY, EDGBASTON, BIRMINGHAM, 15, to whom applications (three copies) should be sent by 16th NOVEMBER, 1960. D 376

APPOINTMENTS OPEN

CIVIL ENGINEER

STEEL, PEECH & TOZER, Branch of the United Steel Companies Limited, have a vancancy for a CIVIL ENGINEER in their New Construction Department, for work in connection with extensions and additions to plant. Candidates should be aged 30 to 45, possess a sound practical and theoretical knowledge in Civil Engineering, be fully conversant in the use of surveying instruments, and be able to control contract labour. The position is a permanent one and a Staff Superannuation Scheme is in operation. Commencing salary according to qualifications and experience. Applications should be made in writing to

The Labour Manager,
Steel, Peech & Tozer,
P.O. Box 50,
The Ickles,
Rotherham, Yorks

D 359

OVERSEAS APPOINTMENTS SIMON-CARVES LIMITED

require

MECHANICAL ENGINEERS for overseas contracts. Applications are invited from men between 30 and 40 years of age who have experience in the erection and installation of electrical and heavy mechanical engineering plant, including H.P. compressors, pipelines and vessels. A.M.I.Mech.E. or similar qualification desirable.

Applications, quoting Reg. No. SC130, with details of age, experience and qualifications, should be forwarded to CONTRACT LABOUR DEPT., SIMON-CARVES, LTD., CHEADLE HEATH, STOCKPORT. D 246

WELL KNOWN PUBLIC COMPANY making engineering components has opening for

GRADUATE ENGINEER

He should be in his twenties, earning a four figure salary, having experience of medium engineering with proven impact on productive efficiency and, above all, show evidence of high management potential.

Initially he will act as engineering staff officer to the manager of a small specialised London factory. Given successful achievement here, subsequent career prospects are excellent. We are specifically seeking a man whom we can develop as a senior engineering executive.

Applications, which should include full career details and which will be treated in strict confidence, should be sent to BOX D 356, Ref. PDM/GE., Offices of ENGINEERING.

Plessey

(Swindon Region)
Kembrey Street, Swindon

Designers & Draughtsmen

The rapid expansion of this leading organisation is calling for a further recruitment of qualified drawing office and engineering personnel.

The Group comprises many and varied projects. Young men with the requisite education and background could look forward to a considerable widening of their experience.

There are vacancies in each of the following Divisions at Swindon:—

ELECTROLYTIC CAPACITORS
COLD MOULDINGS
MOULDED FIBRE PRODUCTS
GENERAL MACHINE SHOPS
WIRING AND CONNECTORS
INDUSTRIAL HYDRAULICS
SINTERED METALS
SEMICONDUCTORS
MAGNET FOUNDRY
SHEET METAL AND OTHER UNITS.

Successful applicants from the London Area will be considered for an early allocation of a house in conjunction with the local authorities.

TERMS AND CONDITIONS OF EMPLOYMENT INCLUDING IMMEDIATE ENTRY INTO THE PLESSEY STAFF PENSION SCHEME WILL BE DISCUSSED AT PRELIMINARY INTERVIEWS TO BE HELD IN LONDON AND IN SWINDON BY ARRANGEMENT.

Please write in confidence:

Regional Personnel Manager:

THE PLESSEY COMPANY LIMITED
Kembrey Street, SWINDON, Wiltshire

Quoting Reference DD/1. D 347

THE INSTITUTION OF STRUCTURAL ENGINEERS

APPOINTMENT OF

SECRETARY

Applications are invited for the position of Secretary of the Institution of Structural Engineers from men between the ages of 35 and 50. Applicants, who must be British, should possess a University degree, preferably with honours, or be a corporate member of a chartered engineering Institution, or have other suitable professional or service qualifications, and must have wide administrative experience.

Commencing salary will be £3000 per annum; there is a contributory superannuation scheme.

The successful applicant will be required to take over from the retiring Secretary on the 1st October, 1961.

Further particulars can be had on application to **The Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1,** the envelope to be marked "**Appointment of Secretary**".

The closing date for the submission of the detailed applications will be **30th November, 1960.** D 340

J. H. FENNER & CO. LTD.
POWER TRANSMISSION ENGINEERS
MARFLEET · HULL

ASSISTANT PRODUCT DESIGN ENGINEER

This rapidly expanding Company of international repute invites applications for the post of Assistant Product Design Engineer. The successful candidate will be required to organise the preparation of designs and production drawings for ranges of products used in Mechanical Power Transmission. Applicants should be aged 28/35 years of age, apprentice trained design draughtsmen with good background of general engineering and possess minimum qualification of H.N.C. They should have experience of the design of gears for specific duties and the selection and application of ball and roller bearings.

The Company offers excellent conditions of service. Salary commensurate with responsibilities, qualifications and experience. Pension scheme and life assurance.

Applications in confidence giving full details of qualifications and experience should be addressed to the Personnel Manager. D 331

TAYLOR WOODROW CONSTRUCTION LTD.

due to the development of the

MECHANICAL INSTALLATION DEPARTMENT

require

ESTIMATORS

and

SITE AGENTS

with experience of chemical, refinery and heavy industrial installations.

These are excellent opportunities to join a rapidly expanding department and offer scope for responsibility and advancement to men of ability. Interviews can be arranged at any time including evenings and Saturday mornings with travelling expenses paid.

Write giving details of career to:
Personnel Manager,
545, Ruislip Road, Southall, Middlesex.
D 321

DIRECTOR

A large Engineering Group, comprising several companies, is seeking a Director to be responsible to the Chairman for the implementation of policy and the general direction of the Group's Development and Design effort.

This Directorship demands a man of the highest calibre, age 35-50, with:

1. Considerable practical experience of light mechanical and ancillary engineering products.
2. The ability to promote and evaluate new ideas.
3. The energy, drive and tact to get things done.

Commencing salary of £5000-£6000 per annum with considerate superannuation and other attractive benefits.

Candidates should write, in confidence, stating experience, qualifications, education, age and recent earnings to BOX D 380, Offices of ENGINEERING.

WORKS ENGINEERING

Applications are invited for the following posts:—

SERVICES ENGINEER

Duties involve the selection of process plants (steam, vacuum, hydraulic) and design of associated piped service systems.

Some experience of this work is necessary together with technical qualification to H.N.C. Mechanical level.

ASSISTANT ENGINEER

Duties involve design and specification work related to maintenance and modification of existing plant and factory services.

A good general mechanical engineering background is necessary and a technical qualification to minimum O.N.C. Mech. level.

DESIGNER/DRAUGHTSMAN

Duties involve draughting and some design on a wide range of plant and factory layout work.

Good experience in this field is required together with a technical qualification to minimum O.N.C. Mech. level.

The Works Engineering department is concerned with a wide and interesting range of process plant, machines and general services and offers good career prospects in an expanding organisation employing 1,500 people.

If you are interested in this field of work please apply, giving details of age, experience, qualifications and current salary to:—

Personnel Manager :

THE MICANITE & INSULATORS CO. LTD.

Empire Works, Blackhorse Lane, Walthamstow, London, E.17

D 365

ASSISTANT CHIEF DESIGNER

for

J. C. Bamford (Excavators) Limited

a medium-sized Company situated in attractive surroundings near Uttoxeter. This is a new appointment arising from rapid expansion of the Company and there are clear prospects of promotion in the future. Initial salary will be according to qualifications and experience.

The Assistant Chief Designer, who will be directly responsible to the Chief Designer, will have complete technical and operational control over the Drawing Office. The Drawing Office staff numbers approximately nine and will increase by at least 50 per cent. during the next twelve months. The Assistant Chief Designer's main function will be to plan and control their work; in addition he will supervise the Prototype Department in the absence of the Chief Designer.

The main qualifications are an engineering apprenticeship, at least eight years close technical experience on the drawing board in design for production relating to hydraulics, transmissions, suspensions, tyres and fabrications, at least three years at Section Leader level and a personal knowledge of the suppliers of components. Preferred age 30/40.

Please write briefly in first instance, quoting Reference No. 863, to:

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidate's permission.

D 341

ADMIRALTY—NAVY WORKS DEPT.

ELECTRICAL & MECHANICAL ENGINEERING DRAUGHTSMEN

Vacancies exist in Navy Works Department Drawing Offices as shown below and occur at Establishments elsewhere in United Kingdom from time to time.

The posts are non-pensionable but there will be opportunities for transfer to the Established staff.

Applicants must be competent Draughtsmen and experienced in one or more of the following types of work:—

Electrical (vacancies at Pinner (Middx.), Portland and Devonport).
(*a*) Preparation of specifications, drawings and schedules for electrical equipment. Précis of firms' tenders.
(*b*) Electrical installations in domestic and industrial buildings.
(*c*) Cable installations, switchgear, etc.
(*d*) Airfield lighting.

Mechanical (vacancies at Pinner (Middx.), Portsmouth, Portland, Liverpool, Rosyth, London).
(*a*) Preparation of specifications, drawings, schedules and précis of firms' tenders.
(*b*) District heating, including boiler installations, heating and air conditioning of domestic and specialist buildings.
(*c*) Layouts of engineering installations and workshop machinery.
(*d*) All classes of lifting appliances, pumping installations, test plants, cooking equipment, etc.

Possession of O.N.C. or similar qualification will be an advantage. Consideration will be given to successful candidates being granted assistance to obtain technical qualifications.

Salary (Men): National Rate—subject to slight variation dependent on location: starting from £580 (at age 21) to £870 (28 and over): maximum of scale—£955 p.a. (National Rate).

Opportunities occur for promotion to Leading grade—salary maximum £1115 p.a. (National Rate).

Five-day week: annual leave 18 days rising to 22 after 10 years.

Candidates, who must be British subjects, are invited to apply in writing, giving details of qualifications and experience to Director General, Navy Works, Admiralty, Chamberlain Way, Pinner, Middlesex.

D 313

SCOTTISH HOME DEPARTMENT

ROAD ENGINEERS

Applications are invited for posts of Engineering Assistant Grade II on the staff of the Chief Road Engineers (Scotland) based on Edinburgh, Oban and Inverness.

Candidates should be men, preferably over 26, who have served an apprenticeship or equivalent period of training with at least five years' subsequent experience, e.g. with a civil engineering contractor, local highway authority or consulting engineers. They should hold O.N.C. or comparable qualification. H.N.C. an advantage.

Salary £950 rising to £1085 less £25 to £30 meantime for Oban and Inverness. Unpensionable at first but opportunity to gain pensionable post.

Applications, with details of qualifications, experience and age to:
ESTABLISHMENT OFFICER,
SCOTTISH HOME DEPARTMENT,
ROOM 364, ST. ANDREWS' HOUSE,
EDINBURGH, 1,
by 29th NOVEMBER, 1960. D 342

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE, WANDSWORTH HIGH STREET, S.W.18
Required JANUARY, 1961, ASSISTANT GRADE "B" plus £120 Special Allowance to teach Production Engineering subjects to H.N.C. and Final C. & G. Level and to be responsible for organising the Engineering Workshops with special reference to Machine Tools.

Graduate or equivalent qualifications, Industrial and Teaching experience desirable. Salary: £700 by £27 10s. to £1150 plus £120 allowance plus London Allowance and additions for qualifications and training.

Increments within scale for approved experience.

Application forms from SECRETARY, quoting (FE.3/E/2777/11), returnable by 18th NOVEMBER. D 348

MINISTRY OF AVIATION

MINISTRY OF AVIATION require RADIOGRAPHER at BIRTLEY, CO. DURHAM, for the X-RADIOGRAPHY of a variety of welded and brazed joints, and of castings. Quals.: Recognised eng. apprenticeship or equiv. training. Sound knowledge and practical exp. of X-radiography as applied to metal, to metal joints and to castings, including the formulation and application of the necessary techniques, and the interpretation of the results. Some knowledge of radiation protection and safety precautions is desirable. Salary: £825 (age 28) to £925.—Application forms from MANAGER (PE.3304), MINISTRY OF LABOUR, PROFESSIONAL AND EXECUTIVE REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. D 370

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

Honours graduates in Engineering interested in gas flow in internal combustion engines are invited to apply for appointment as SENIOR RESEARCH ASSISTANT. Salary scale £1050 by £50 to £1400, with superannuation and family allowance, initial salary according to qualifications and experience.—Conditions of Appointment and Form of Application which should be returned by 3rd DECEMBER, 1960, from the REGISTRAR. D 362

SURREY EDUCATION COMMITTEE

GUILDFORD COUNTY TECHNICAL COLLEGE

STOKE PARK, GUILDFORD

Required 1st January, 1961:—
ASSISTANT TEACHER for Mechanical Engineering, O.N.C. and C. and G. courses. Salary: Burnham Technical Scale Grade B, £700-£1150 p.a., with allowances for approved experience, qualifications and training.

S.A.E. to Principal for further particulars and application form to be returned as soon as possible. D 350

UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER or ASSISTANT LECTURER in MECHANICAL ENGINEERING. Candidates should have experience in the fields of Theory of Elasticity, Plasticity or related fields. Salary Scales: Lecturer, £1050 by £50 to £1400 by £75 to £1,850 with an efficiency bar at £1475. Assistant Lecturer, £800 by £50 to £950. The initial salary will depend on qualifications and experience. Further particulars should be obtained from the SECRETARY AND REGISTRAR to whom applications (7 copies from United Kingdom applicants) should be sent not later than 20th NOVEMBER, 1960. D 346

NATIONAL COAL BOARD—

NORTH EASTERN DIVISION

CIVIL ENGINEERING ASSISTANT REQUIRED in CASTLEFORD, YORKSHIRE, Area. Salary, £825-£1275 per annum.

Candidates should have experience in the design and construction of industrial works in reinforced concrete/structural steel or general civil engineering works including roads, railways and drainage; have passed Sections I and II of the Institution of Civil Engineers' Associate Membership Examinations or possess an equivalent qualification. Experience in the preparation of Specifications and Bills of Quantities an advantage.

Apply to AREA STAFF MANAGER, NO. 8 (CASTLEFORD) AREA, ALLERTON BYWATER, CASTLEFORD, by 12th NOVEMBER. D 336

ENGINEER III

MINISTRY OF AVIATION requires ENGINEER III at ROYAL RADAR ESTABLISHMENT, MALVERN, responsible for investigation in fields of machining techniques, pressure hobbing using hot and cold flow techniques, and special processes mainly concerned with production of experimental equipment. Quals.: Engineering apprenticeship and Corporate Membership of Electrical or Mechanical Engineers or equivalent quals. Experience in instrument or precision light engineering for development and research workshops. £780 (age 25)-£1220 p.a. (provincial male). Commencing salary at age 34 or over £1065. Not Established but opportunities to compete for establishment may arise.—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C836/OA. D 367

DRAUGHTSMEN

MECHANICAL, ELECTRICAL AND HEATING AND VENTILATING ENGINEERING DRAUGHTSMEN. Pensionable posts for men and women aged at least 20 on 1.6.60 with at least 3 years' training, including adequate practical experience with appropriate technical study. Appropriate O.N.C. is essential, and at least one year must have been spent in full-time drawing office work. Salary (men, London) £557 10s. (20) to £895 (28 or over). Scale maximum £980. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/68-69/60. Closing date 31st DECEMBER, 1960. D 368

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

RIO TINTO EDUCATIONAL TRUST AWARDS tenable at the ROYAL SCHOOL OF MINES in OCTOBER, 1961:—

RIO TINTO RESEARCH BURSARY—£550-£850 p.a. (according to qualifications and experience), out of which fees must be paid, normally for two years for research connected with mineral exploration, mining, mineral dressing or extraction metallurgy. Candidates must hold an appropriate honours degree.

RIO TINTO ADVANCED COURSE BURSARIES —£475-£675 (according to qualifications and experience), out of which fees must be paid, for a post-graduate diploma course of one session in Applied Geophysics, Mineral Exploration, Mineral Dressing or Mining. Candidates must hold an appropriate first degree.

Further particulars, and application forms (to be returned by 31st March, 1961) obtainable from the REGISTRAR, IMPERIAL COLLEGE, SOUTH KENSINGTON, S.W.7. D 357

THE QUEEN'S UNIVERSITY OF BELFAST

THE SENATE OF THE QUEEN'S UNIVERSITY OF BELFAST invites applications for a LECTURESHIP in MECHANICAL ENGINEERING from 1st JANUARY, 1961 or such other date as may be arranged. Preference will be given to candidates who are interested in Strength of Materials. Salary range, £1050 to £1850 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience.

Applications should be received by 30th NOVEMBER, 1960.

Further particulars may be obtained from G. R. COWIE, M.A., LL.B., J.P., SECRETARY. D 317

STRUCTURAL ENGINEERING DESIGN DRAUGHTSMEN

AIR MINISTRY, Works Design Branch, requires in LONDON STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 3745), to AIR MINISTRY, W.G.d, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 894

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF MECHANICAL ENGINEERING UNIVERSITY ENGINEERING RESEARCH

Applications are invited from GRADUATES in some branch of engineering, metallurgy or physics who have had some industrial or research experience, to RESEARCH SCHOLARSHIPS in the following fields:

ADVANCED METAL FORMING PROCESSES (two scholarships).
AUTOMOBILE ENGINEERING (one scholarship).
VIBRATIONS OF GRINDING MACHINES (one scholarship).

These scholarships have been established by several industrial firms who are also supporting the actual investigations. Their value will be in the range of £800-£1100 per annum. Successful applicants will be allowed to register for a higher degree, usually a Ph.D. in the case of good Honours graduates.

Applications should be addressed to the PROFESSOR OF MECHANICAL ENGINEERING, THE UNIVERSITY, BIRMINGHAM, 15. D 375

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF MECHANICAL ENGINEERING UNIVERSITY ENGINEERING RESEARCH

Applications are invited for two vacancies for ASSISTANT RESEARCH ENGINEERS to work on newly-instituted investigations into advanced metal forming processes.

Qualifications required: Higher National Certificate or similar qualification, with plenty of drive and initiative. Experience in metal extrusion desirable but not necessary.

Salary in the range of £750 to £1000 per annum, according to experience.

Apply in writing to the PROFESSOR OF MECHANICAL ENGINEERING, THE UNIVERSITY, EDGBASTON, BIRMINGHAM, 15. D 374

CITY AND COUNTY OF BRISTOL EDUCATION COMMITTEE BRISTOL TECHNICAL COLLEGE

ASHLEY DOWN, BRISTOL, 7.

(2nd Advertisement)

The Governors invite applications from suitably qualified and experienced persons for appointment to the teaching staff as ASSISTANT GRADE B.

The duties mainly comprise the teaching of WORKSHOP TECHNOLOGY AND PRACTICE to students following National Certificate of City and Guilds of London courses. Ability to assist with associated Science Calculations and Drawing, an asset.

SALARY: Burnham Technical Scale, 1959, £700-£1150 p.a. (with additions for training and graduate or equivalent qualification). Placing on scale determined by previous approved industrial or teaching experience.

A suitably experienced applicant may qualify for an allowance of £120 additional to above scale.

Details and application forms from the REGISTRAR, quoting reference "BTC 60/2," to be returned as soon as possible. D 382

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the appointment of a LECTURER with interests in one or more of the following fields:

PLASTICITY AND METAL FORMING
MACHINE TOOLS AND METAL CUTTING
VIBRATION

Applicants should have marked ability at conducting and supervising research in their field of interest, and an Honours degree in some field of Engineering, Physics or Mathematics.

The salary scale will be £1050 by £50 to £1400 by £75 to £1550; £1550 by £75 to £1850. The appointment will carry family allowance and F.S.S.U. benefits and the initial salary will be related to qualifications and experience.

Further particulars may be obtained from the REGISTRAR, THE UNIVERSITY, EDGBASTON, BIRMINGHAM, 15, to whom applications (three copies) should be sent by 16th NOVEMBER, 1960. D 376

APPOINTMENTS OPEN

CIVIL ENGINEER

STEEL, PEECH & TOZER, Branch of the United Steel Companies Limited, have a vancancy for a CIVIL ENGINEER in their New Construction Department, for work in connection with extensions and additions to plant. Candidates should be aged 30 to 45, possess a sound practical and theoretical knowledge in Civil Engineering, be fully conversant in the use of surveying instruments, and be able to control contract labour. The position is a permanent one and a Staff Superannuation Scheme is in operation. Commencing salary according to qualifications and experience. Applications should be made in writing to

The Labour Manager,
Steel, Peech & Tozer,
P.O. Box 50,
The Ickles,
Rotherham, Yorks

D 359

OVERSEAS APPOINTMENTS SIMON-CARVES LIMITED

require

MECHANICAL ENGINEERS for overseas contracts. Applications are invited from men between 30 and 40 years of age who have experience in the erection and installation of electrical and heavy mechanical engineering plant, including H.P. compressors, pipelines and vessels. A.M.I.Mech.E. or similar qualification desirable.

Applications, quoting Reg. No. SC130, with details of age, experience and qualifications, should be forwarded to CONTRACT LABOUR DEPT., SIMON-CARVES, LTD., CHEADLE HEATH, STOCKPORT. D 246

WELL KNOWN PUBLIC COMPANY making engineering components has opening for

GRADUATE ENGINEER

He should be in his twenties, earning a four figure salary, having experience of medium engineering with proven impact on productive efficiency and, above all, show evidence of high management potential.

Initially he will act as engineering staff officer to the manager of a small specialised London factory. Given successful achievement here, subsequent career prospects are excellent. We are specifically seeking a man whom we can develop as a senior engineering executive.

Applications, which should include full career details and which will be treated in strict confidence, should be sent to BOX D 356, Ref. PDM/GE., Offices of ENGINEERING.

Plessey

(Swindon Region)
Kembrey Street, Swindon

Designers & Draughtsmen

The rapid expansion of this leading organisation is calling for a further recruitment of qualified drawing office and engineering personnel.

The Group comprises many and varied projects. Young men with the requisite education and background could look forward to a considerable widening of their experience.

There are vacancies in each of the following Divisions at Swindon:—

ELECTROLYTIC CAPACITORS
COLD MOULDINGS
MOULDED FIBRE PRODUCTS
GENERAL MACHINE SHOPS
WIRING AND CONNECTORS
INDUSTRIAL HYDRAULICS
SINTERED METALS
SEMICONDUCTORS
MAGNET FOUNDRY
SHEET METAL AND OTHER UNITS.

Successful applicants from the London Area will be considered for an early allocation of a house in conjunction with the local authorities.

TERMS AND CONDITIONS OF EMPLOYMENT INCLUDING IMMEDIATE ENTRY INTO THE PLESSEY STAFF PENSION SCHEME WILL BE DISCUSSED AT PRELIMINARY INTERVIEWS TO BE HELD IN LONDON AND IN SWINDON BY ARRANGEMENT.

Please write in confidence:

Regional Personnel Manager:

THE PLESSEY COMPANY LIMITED
Kembrey Street, SWINDON, Wiltshire

Quoting Reference DD/1. D 347

THE INSTITUTION OF STRUCTURAL ENGINEERS

APPOINTMENT OF

SECRETARY

Applications are invited for the position of Secretary of the Institution of Structural Engineers from men between the ages of 35 and 50. Applicants, who must be British, should possess a University degree, preferably with honours, or be a corporate member of a chartered engineering Institution, or have other suitable professional or service qualifications, and must have wide administrative experience.

Commencing salary will be £3000 per annum; there is a contributory superannuation scheme.

The successful applicant will be required to take over from the retiring Secretary on the 1st October, 1961.

Further particulars can be had on application to **The Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1,** the envelope to be marked **"Appointment of Secretary".**

The closing date for the submission of the detailed applications will be **30th November, 1960.** D 340

J. H. FENNER & CO. LTD.

POWER TRANSMISSION ENGINEERS

MARFLEET · HULL

ASSISTANT PRODUCT DESIGN ENGINEER

This rapidly expanding Company of international repute invites applications for the post of Assistant Product Design Engineer. The successful candidate will be required to organise the preparation of designs and production drawings for ranges of products used in Mechanical Power Transmission. Applicants should be aged 28/35 years of age, apprentice trained design draughtsmen with good background of general engineering and possess minimum qualification of H.N.C. They should have experience of the design of gears for specific duties and the selection and application of ball and roller bearings.

The Company offers excellent conditions of service. Salary commensurate with responsibilities, qualifications and experience. Pension scheme and life assurance.

Applications in confidence giving full details of qualifications and experience should be addressed to the Personnel Manager. D 331

TAYLOR WOODROW CONSTRUCTION LTD.

due to the development of the

MECHANICAL INSTALLATION DEPARTMENT

require

ESTIMATORS

and

SITE AGENTS

with experience of chemical, refinery and heavy industrial installations.

These are excellent opportunities to join a rapidly expanding department and offer scope for responsibility and advancement to men of ability. Interviews can be arranged at any time including evenings and Saturday mornings with travelling expenses paid.

Write giving details of career to:
Personnel Manager,
545, Ruislip Road, Southall, Middlesex.
D 321

TAKERS OFF AND WORKERS UP

Firm of CHARTERED QUANTITY SURVEYORS require TAKERS OFF and WORKERS UP for large Civil Engineering and Building works in the SHEFFIELD AREA. Positions offer scope for advancement.—Reply stating age, experience and salary required to BOX D 373, Offices of ENGINEERING.

MECHANICAL ENGINEER

MECHANICAL ENGINEER, H.N.C. STANDARD, required for non-destructive testing of materials and vessels. Specialised training will be given to successful candidate. Commencing salary £800 a year. Non-contributory pension.—BOX D 379, Offices of ENGINEERING.

DRAUGHTSMEN

Pilkington Brothers Limited have vacancies in their Technical Development Department for three senior and one junior Mechanical Draughtsmen. The work involves the production of design and detail drawings for new plant and for modifications to existing machines. The draughtsmen work closely with Development Engineers on a wide range of problems from small precision mechanisms to automatic glass-handling equipment.

Age range:—Seniors 25-45; Junior 21-25.

Qualifications: Seniors, H.N.C. preferred, but general engineering experience essential. Junior preferably with O.N.C. and general engineering apprenticeship.

Applications, stating age, qualifications and experience, should be addressed to Mr. C. S. Drake, Group Staff Department, Pilkington Brothers Limited, St. Helens, Lancashire. D 381

TECHNICAL SALES

Owing to further expansion, a progressive engineering company in S.W. London supplying specialised machinery to the paper and boxmaking industries throughout the world, wishes to appoint TWO ADDITIONAL QUALIFIED ENGINEERS in its SALES DEPARTMENT.

Essential qualifications are a degree or H.N.C. and an apprenticeship in Mechanical engineering whilst a knowledge of German would be an advantage for one of the appointments. Applicants should be between 25 and 32 years of age. Previous sales experience is not necessary.

The work is responsible and interesting entailing the discussion of both technical and commercial problems with existing and potential customers and requires outstanding personal qualities. Applications, with full details of education, qualifications, age and experience, should be sent to Sales Director, BOX D 383, Offices of ENGINEERING.

DESIGN STAFF

CONSULTING ENGINEERS require QUALIFIED DESIGN STAFF experienced in WORKS OF WATER SUPPLY, SEWERAGE, SEWAGE DISPOSAL AND TRADE EFFLUENT DISPOSAL.

Modern offices, interesting and varied schemes.

Applicants should submit full details of past experience:—J. D. & D. M. WATSON, MM.I.C.E., 67, TUFTON STREET, S.W.1. D 351

MECHANICAL AND CIVIL ENGINEERING DRAUGHTSMAN

MECHANICAL AND CIVIL ENGINEERING DRAUGHTSMAN required for a Drawing Office engaged on all types of work connected with Mining, Quarrying, Hydraulics and Industrial Building Construction. A Superannuation Scheme is in operation. Applications stating qualifications, experience and salary required should be made to THE CHIEF ENGINEER, ENGLISH CLAYS LOVERING POCHIN & CO., LTD., 14, HIGH CROSS STREET, ST. AUSTELL, CORNWALL. D 293

BICC

BRITISH INSULATED CALLENDER'S CONSTRUCTION CO., LTD., have vacancies in their Overhead Line Contracts Department in London for

DRAUGHTSMEN

The work involves the preparation of arrangement and detailed drawings for Electrical Transmission and Distribution Lines. The posts offer advancement to the status of Designer Draughtsman.

Write stating all details, including age and salary required to:

STAFF OFFICER,
BIC Construction Co., Ltd.,
30, Leicester Square,
London, W.C.2.

D 372

GRADUATE CIVIL STRUCTURAL ENGINEERING ASSISTANT

GRADUATE CIVIL STRUCTURAL ENGINEERING ASSISTANT required for airport development work. Application to
NORMAN & DAWBARN,
ARCHITECTS AND CONSULTING ENGINEERS,
7, PORTLAND PLACE, LONDON, W.1.
D 316

RESEARCH ENGINEER (OIL HYDRAULICS)

Applications are invited for a vacancy in a small team in the central research establishment of the Vickers Group. The team is building up novel technologies and developing new types of hydraulic mechanisms. The work requires a thorough understanding of basic principles and the ability to apply it to non-conventional fields. Previous experience in Oil Hydraulics not essential. Candidates should have some post graduate engineering experience and a good honours degree, or its equivalent, in physics or engineering. The post is not administrative. The salary is commensurate with ability, qualifications and experience. Applications should be supported by a brief statement of qualifications and experience and sent to the MANAGING DIRECTOR, VICKERS RESEARCH LIMITED, SUNNINGHILL, ASCOT, BERKS. D 345

CHIEF MECHANICAL ENGINEER

CHIEF MECHANICAL ENGINEER required for Iron Ore Mining Organisation in Goa, Portuguese India, to take charge of the operation and maintenance of all machinery on the mines, which includes earth moving equipment vehicles, screening and crushing plant, conveyors and mechanical loading plant, diesel generators and electrical equipment and associated maintenance workshops.

The applicants should be between 35 and 45, and have a professional qualification in Mechanical Engineering and have at least 4 years' experience in a similar capacity.

Appointment on Contract for 3 years with possibility of renewal. Free furnished accommodation and transport provided.

Applications detailing qualifications, experience and salary required should be accompanied by recent photograph and addressed to PERSONNEL OFFICER, EWBANK & PARTNERS, LTD., 10/11, GROSVENOR PLACE, LONDON, S.W.1. D 364

DESIGN DRAUGHTSMAN

DESIGN DRAUGHTSMAN required by old established firm, MANCHESTER AREA, to prepare confidential drawings of a medical speciality machine using textiles. Machine available for examination, evenings and Weekends. Original drawings lost and new machines required.—BOX D 371, Offices of ENGINEERING.

Engineer

A small company with international connections and operating a modern chemical process plant in the London area wishes to appoint an engineer. After a period of training the successful candidate will become the Works Engineer. This position will require application and initiative in the field of preventative and scheduled maintenance. The supporting team is good. In due course there may be work involving the design, installation and construction of new plant and buildings.

Applicants for this position must have a degree or H.N.C. in chemical or mechanical engineering and some practical experience in maintenance engineering in the chemical industry. They will need to show ability to plan work. Applicants should be able to get on with others and to express themselves clearly.

The successful applicant may be an assistant in the maintenance engineering department who can take more responsibility than his present position provides. A good opportunity exists for applicants between 26 and 35 years of age.

All applications will be treated in strict confidence and should be sent to BOX D 360, Offices of ENGINEERING.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

invite applications from

PHYSICISTS

for posts in the

HEALTH AND SAFETY BRANCH

at their

WINDSCALE AND CALDER WORKS, SELLAFIELD, CUMBERLAND

The Health and Safety Branch is engaged on problems concerned with both the operational and research aspects of safety control of large radio-chemical and reactor plants.

Scientific personnel are urgently required in the field of health and safety and, since this is a national demand, opportunities and long-term prospects are exceptionally good.

Applicants must possess an Honours degree, or equivalent. Previous experience in the field of radiological protection is desirable, though not essential. Training will be provided for suitable applicants.

Salaries are within the scale £860, at age 25, to £1340 p.a.

Working and living conditions are congenial. The surrounding district offers considerable amenities including excellent beaches, and easy access to Lake District.

There is a Staff Housing Scheme and a Contributory Superannuation Scheme.

For further details of these posts, and form of application, you are invited to write, quoting reference P/W. 60/J2, to:

Staff Appointments Officer,
UNITED KINGDOM ATOMIC ENERGY AUTHORITY
PRODUCTION GROUP,
Windscale Works, Sellafield,
Seascale, Cumberland. D 353

ADVERTISEMENT RATES

'Engineering'

Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates: per page (12 in. by 9 in.) .. £100
per half page £54
per quarter page £29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.) .. £100
per half page £54
per quarter page £29
per single column inch .. £2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line 4s. 6d
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

Company Meetings

Quarter page £29 : half page £54 : full page £100

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing Screen 100.

ORDERS TO: "Engineering," 36, Bedford Street, London, W.C.2 Telephone TEMple Bar 3663

COMPANY MEETING

TOLEDO WOODHEAD SPRINGS

SUBSTANTIALLY INCREASED TURNOVER AND EARNINGS

MR. FRANK WOODHEAD ON THE YEAR'S DEVELOPMENTS

The 22nd annual general meeting of Toledo Woodhead Springs Limited will be held on November 25 at Coronation Works, Aycliffe, Co. Durham.

The following is an extract from the circulated statement of the chairman, MR. FRANK WOODHEAD:

The group trading profit for the year is £170,487 before deduction of depreciation. This is most satisfactory as it is a seventy per cent. improvement over our previous year's result. Most of this increased earning capacity has come from the substantial increase in turnover, which in fact, during the current year has strained our facilities to the fullest. Moreover during the year the financial gains which arose from the fuller use of our facilities were further added to by the introduction of more effective methods of production.

It was necessary also to make provision for the loss of £7,500 recorded by T.A.I.P. (Engineers) Limited our subsidiary engaged in tooling and production planning. This subsidiary reported last year as suffering from a decline in the aircraft industry, during the last financial year was unfortunate in being involved in the Missile Programme and suffered from the serious cut back which occurred.

Business prospects, however, as reported over the last two or three months show an improvement.

Part of our increased activity has been due to the resurgence of the demand for springs for trucks and heavy vehicles; part from an ever increasing demand for our Kantlink Lockwashers, especially from export markets and partly from a highly pleasing growth in the spring work we do for the railways.

During the year, due to the increasing demands for our Company's products, we took on lease a further factory of 30,000 sq. ft. adjacent to our Coronation Works, a matter on which we now congratulate ourselves in view of the large order which we have received for laminated leaf springs from the Ford Motor Company of Detroit, for without the additional space we could not have taken this order.

There is being spent, and to be spent, £80,000 in equipping this factory with the most up-to-date spring making machinery.

In the latter half of the year under review, your Company was offered the Light Spring Section of an old established firm by the name of John Spencer & Sons (1928) Limited. We accepted this offer as their spring production completed our range of coil springs so that we can supply the smallest coil spring up to springs suitable for front and rear suspensions of motor cars or tracked armoured fighting vehicles.

The Board of Directors are of the opinion that it is essential for an introduction of further capital to the sum of £225,000. Your Directors have enclosed along with the Reports and Accounts, a "rights" offer of one share for every two held, at a price of 10s. 6d. per share. An increase of nominal capital is also required and a Notice of a Special Meeting to authorise this is likewise enclosed.

Prospects

The change in the prospects of this Company since I addressed myself to you last year is most gratifying. Last year the future held many uncertainties, but now the developments are showing themselves more clearly.

With the trade negotiations which are pending and developments which are taking place in the group production facilities, your Board are confident that the Company's immediate prospects are very good indeed.

As a result of this confidence it has been the decision of your Directors to increase the final dividend to 12½ per cent., less tax, thereby making a total annual distribution of 20 per cent. for the year, which is 2½ per cent. greater than was paid last year.

Furthermore, it is your Directors' intention, present progress being continued, to maintain that dividend of 20 per cent. on the increased capital. D 352

Companies

The Many Sided Strength of Pye

MR. CHARLES ORR STANLEY, chairman of PYE, has made it plain that the Pye-E. K. COLE merger is very much more a forward looking affair than simply a financial step brought on by market conditions.

Of the effects of the credit squeeze, Mr. Stanley observes sharply it would take much more than such a merger to overcome its effects.

What the future collaboration with the Ekco interests brings to Pye is, most essentially, the firm's solidly established place and considerable capacity in manufacturing plastics mouldings and parts—for most of the refrigerator firms, for the car makers (dashboards and instrument panels), washing machine and other domestic appliance makers and even for other radio and television set producers.

There is a distinctive Ekco contribution to the marriage on the electronics side as well. Adding this to Pye's successful if unwelcome entry to the family of Post Office equipment manufacturers produces a total of expansion of interest which makes 1960 a notable year for the company, even though it has been a bad year on the consumer sales side.

The new company shape of the radio and television industry puts three important groups at the top, all being approximately the same in size. They are the £25 million Pye-Ekco group whose formal establishment has yet to be completed, the THORN ELECTRICAL concern and PHILIPS.

Since the hire purchase and credit restrictions began depressing television and radio set sales Ekco have been feeling the pinch as badly as any. Over the last two months some 800 of their employees have been dismissed. From the statements of the two chairmen, and looking at the record of expansion of Pye, and for that matter of Ekco, it appears a reasonable surmise that assurances given to employees at Ekco's works at Southend, Essex, that there will be no more dismissals for the time being, may turn out to cover a much longer period than the immediate future.

Contractors Views on Air Conditioning Applications

Among the air conditioning engineering contracting firms who have explained something of their experience in the field (following ENGINEERING's survey among industrial users) were STEELS ENGINEERING INSTALLATIONS Limited, of Sunderland.

Steels' main interest in this direction is in the marine industry where the company has specialised for many years in mechanical heating and ventilating of cargo and cargo-passenger vessels, including tankers, developing the air conditioning specialisation rapidly over the last four or five years.

Considering the whole range of fans, motors, starters, air filters, air heating and cooling coils, pumps, self-contained air conditioning units, ozone units, refrigeration sets, air discharge grilles, louvres, thermostatic controls and trunking, the company expects its expenditure here to increase by fifty per cent over last year, and this despite the present difficulties in shipbuilding.

The company expects air conditioning, as distinct from heating and ventilating, to make rapid progress in marine applications in the next few years, and also in land applications. Improvements in the design of self-contained packaged air conditioning units are also predicted.

Following American Trends

STURTEVANT ENGINEERING suggest that the present trends in Britain appear to be following those of the United States in the promotion of air conditioning for personal comfort, entailing cooling during the summer months with some emphasis on air filtration.

"But," say the company, "the necessity for providing conditioned air, other than warmed and filtered air, is not a matter of importance in view of the temperate climate ruling in this country, as so the use of air cooling is felt to be a luxury where personal comfort is concerned and is offered to attract that section of the public, and of business, whose primary consideration is not that of cost."

Among engineers concerned with this subject complaints about looseness of terminology are not infrequent. The company point out that the term air conditioning—"is very loosely used and can denote anything from a small ventilation plant with air filtration to a full air conditioning plant producing close temperature and humidity control, employing refrigeration where necessary, and an air filtration unit that removes practically 100 per cent of the impurities in the air."

Carrier Engineering and the BBC Television Centre

Probably the largest non-industrial application of air conditioning in Europe is the BBC's Television Centre in West London.

The Carrier Engineering Company were responsible for this part of the work, an undertaking involving 19 air conditioning plants, 22 ventilating plants, 8 lavatory extracting plants, 2 absorption refrigeration machines and the system of automatic control.

Each of the seven large studios has its own air conditioning plant designed to maintain comfortable conditions with up to a maximum of 600 people present and a lighting load of 300 kW. Special care was needed to provide unusual flexibility in the distribution of air in order to keep up reasonable conditions despite the great variety of scenery and lighting arrangements.

"Raw" air for cooling the apparatus bays is provided through special plant.

A central control room for the engineering services is under Studio 4. All motors, except those which are for special reasons controlled locally are governed from the central position. The installation contains 123 fans, 16 pumps, 151 electric motors, 1,600 filter cells, 10 miles of ducting, 2½ miles of piping, 150 automatic controls and 900 fire dampers.

This, of course, is air conditioning on the grand scale. But the future may be expected to bring industrial, commercial and service buildings of comparable dimensions and potential.

Castrol Intensifying Services in Australia

The CASTROL GROUP have sent one of their principal production oils and machine tool lubrication staff to Australia for a nine month tour of industrial centres, with particular reference to the development of the industrial oils business, especially on the machine tool side.

Mr. Lance Moore (inset), who has occupied senior technical posts with

such Castrol companies as W. B. DICK and FLETCHER MILLER, was responsible for the planning and direction of the production oil servicing arrangements of Castrol at the Paris European and London International machine tools exhibitions.

While Castrol is putting in this effort on its Australian market, the Sandwich, Kent, engine-driven power plant manufacturers, PETBOW Limited, have combined with PYE INDUSTRIES of Australia to form a new company, which will be known as PETBOW PTY. Limited.

Petbow produce welding and generating equipment, floodlighting equipment, mobile workshops and switchboards and other electric plant. Its Australian company will gradually build up operations until the full range of products of the UK concern are being made. Magnicon Alternators, under licence from the MACFARLANE ENGINEERING Company, of Scotland, will also be produced by Petbow Pty., which will be located at Huntingdale, Victoria.

Further Diversification by Gloucester Wagon

Another difficult year with a substantial drop in earnings is forecast for the GLOUCESTER RAILWAY CARRIAGE AND WAGON Company, by their chairman, General Sir William Morgan.

The principal reason for the company's present position is the inability to obtain sufficient orders for railway rolling stock to keep the carriage and wagon works working at more than a fraction of their capacity. Sir William traces this to the British Transport Commission's policy of keeping its own railway workshops fully employed. The result being to offer to private firms a volume of work well below the manufacturing capacity in the country.

A general scramble for the work available has brought on price cutting and the acceptance by producers, among them Gloucester Wagon, of contracts at uneconomic prices in order to avoid a major reduction in the labour force.

Although this has limited the company's ability to compete successfully in the overseas markets some useful contracts have been secured from customers abroad.

There are at least four reasons why the long term prospects for the company are a great deal better than the immediate future. One of the subsidiary concerns is the Gloucester foundry where heavy investment has been made in modern equipment for the production of malleable iron castings. This is now thought to be one of the best equipped foundries of its type in the country and is operating at full capacity.

A furniture making subsidiary, HATHERLEY'S, has had a very active year, its output reaching a record level. A third associated company, GARDNER'S, is also meeting a growing demand for its products.

JOSEPH KAYE AND SONS, the Leeds railway carriage and domestic lock manufacturers, was brought into the group last autumn and considerable expansion plans are in hand.

This year, the centenary year of the company, also saw the end of the policy of depending on railway rolling stock as the principal business. The chairman, in his annual report, says that the directors have decided that they "must find and develop other lines of manufacture suited to the skills, equipment and accommodation available in our works."

One of the first of these steps has been to take a financial interest in the WINGET Company. It is hoped to use excess manufacturing capacity at Gloucester to carry out orders for Winget which are above the capacity of that concern's facilities.

TI New £60 million Steel Works near Rotherham

TUBE INVESTMENTS have the approval of the Iron and Steel Board for the development of a £60 million integrated steel works by its PARK GATE IRON AND STEEL Company subsidiary on a site alongside the Park Gate Works near Rotherham.

The new works will have an output of about 425,000 tons a year, bringing the company's total annual production to 875,000 tons. Work on the new plant is to start next year. It is due to be commissioned early in 1964 coming into full operation by the following year. The money will come partly from Tube Investment's own resources and partly from borrowing.

Using home ore, the works will initially include ore preparation plant, a blast furnace, a steelmaking department producing steel by the "Kaldo" process and an electric furnace, and a blooming mill followed by a continuous billet mill. The finishing plant will include a 10 in continuous rod and bar mill. A continuous narrow strip mill will be sited near to the 11 in continuous bar mill installed in 1953.

The outlet for the new works production will be the growing demand of the TI group and also that of Park Gate's traditional trade. Provision has been made in the current plans for the modernisation in 10 to 15 years time of the existing steel works.

INTERNATIONAL CONSTRUCTION Company and BYLANDER, WADDELL & PARTNERS will be the principal engineering consultants.

The Land Rover

For the second article in the new Product Profile series ENGINEERING has chosen for review one of the outstanding vehicles of our time.

THE modern motor car is the product of an engineer-stylist relationship: a combination of the mechanics and electrics of the engineer, and the curves and chromium of the stylist. All, that is, except one—the Land Rover.

Here is a purely functional cross-country car with hardly any curves and no chromium; and one whose design and production are every bit as much the result of all that is best in British engineering as are the fast luxury cars also turned out by the Rover Company Limited. But, it may be argued, who except perhaps the occasional farmer buys such a car? The answer may be deduced from the figures for motor car production in the United Kingdom during the first twelve years of the Land Rover's existence, from the beginning of 1948 to the end of 1959. Compared with the total production of just over 8 million private cars from all manufacturers, almost exactly a quarter of a million Land Rovers were made. And with an ever expanding programme for their production, the Rover Company envisage that the half million mark will be reached around 1966, or earlier.

Basically the Land Rover is an all-purpose go-anywhere vehicle with power take-off if required. It has blossomed into a variety of standard and special forms to suit the individual customer. This in itself is unusual for a moderately priced present-day car.

The story of the Land Rover's inception is closely bound up with the position in which the company found themselves at the end of the Second World War. Unlike other more fortunate car firms no vehicles had been produced at all since 1939, all Rover's resources having been turned over to the production of aircraft equipment. Clearly a vehicle was needed which could go into production with the minimum of time spent on development, would use the minimum of steel, and would have immediate appeal in the home market. It was felt that such a vehicle would tide the firm over until such time as they could once more start concentrating on turning out luxury cars.

At that time Mr. S. B. Wilks was managing director, and his nephew, Mr. M. C. Wilks, was technical director. They were using a Willys Jeep on farm work in Scotland, and they soon saw the potential of a 4-wheel drive vehicle for the home market, particularly for use by farmers to gather the much-needed crops. No greater contrast with the luxury cars of earlier years could possibly be imagined; nevertheless, the Rover Company decided to go ahead with such a vehicle, capable of going anywhere and requiring the minimum of maintenance. To this end the already well-established high quality of Rover engineering techniques would contribute to the full, and this was later to play a big part in the new vehicle's popularity. A section of Rover's wartime aircraft factory, Meteor Works, Solihull, near Birmingham, was therefore put on to Land Rover production; firstly a number of prototypes and then production models.

When the first one appeared in 1948 the biggest innovation was in the form of construction. A box section was adopted for the chassis members for reasons of strength, and the body was more closed in to suit the English climate. To overcome the shortage of steel (priorities in those days being given to firms with an established export market) aluminium was used wherever possible in the construction of the body. This also had the advantage of being both light and non-corrosive, and all these features persist to this day.

The engine first used in the Land Rover was the well established Rover 1·6 litre petrol engine.

It was very soon found that the appeal of the Land Rover was far wider than had been anticipated, and in particular there was a strong demand overseas. The car that had been originally conceived as a stop-gap now looked like becoming a winner, and steps had to be taken to increase the rate of production to keep pace with the demand, a process of expansion that has continued ever since.

Today Land Rovers represent the most important product of the Rover organisation. Far from being confined to the home market for which they were originally intended, 75 per cent are now sold overseas and this proportion is gradually rising as the total turnover increases. The principal overseas markets are Australia, Africa and New Zealand, and there are Rover agents and distributors in almost every sterling and some dollar countries. They are by no means confined to civilian use. Today they form part of the military strength of nearly thirty countries including Britain, New Zealand, Australia, Rhodesia, Malaya, South Africa and Burma. Land Rovers are also ideal for police patrol duties and are thus employed in over thirty foreign countries including Canada, Kenya, South Africa, Brazil, Belgium and Switzerland. It is therefore no exaggeration to state that the Land Rover has vastly exceeded its early expectations.

During development from the early prototype models to the present day Series II, the Rover Company has always taken very careful note of customers' criticisms and where possible modified the design to meet them. Among changes that have been made during the evolution of the Land Rover may be mentioned the following:

(1) In 1950 the gearbox was slightly modified to enable the four-wheel drive, previously permanently engaged, to be changed to normal two-wheel simply by moving a lever. This provided a saving in both power consumption and tyre wear when running on metalled roads.

(2) In 1951 the original 1·6 litre 4-cylinder engine was replaced by Rover's then new 2 litre 4-cylinder petrol engine to provide increased power.

(3) Also, the wheelbase of 80 in was increased to 86 in by moving back the rear axle. This flattened the angle of the propeller shaft and reduced wear on the universal joints.

(4) In 1953 the Long Land Rover was introduced additionally, with a wheelbase of 107 in, compared with the 86 in of the Regular Land Rover, as the normal version became known. The Long version fulfilled the requirements of the customer requiring extra carrying capacity.

(5) In 1957 the Rover 2 litre 4-cylinder diesel engine was introduced as an alternative to the petrol engine to offer greater economy. To accommodate it the front axle was moved 2 in forward, and this was done on all models for the sake of standardisation, the wheelbase of the Regular and Long Land Rovers becoming 88 in and 109 in respectively.

(6) 1958 saw the introduction of the Series II Land Rover in both Long and Regular forms (Figs. 2, 3 and 5), after which production of the Series I ceased. In the Series II the styling and comfort were improved, which increased the track by 1½ in. At the same time in the petrol-engined version the 2 litre engine was replaced

Fig. 1 (above) One of the early prototypes undergoing field trials.

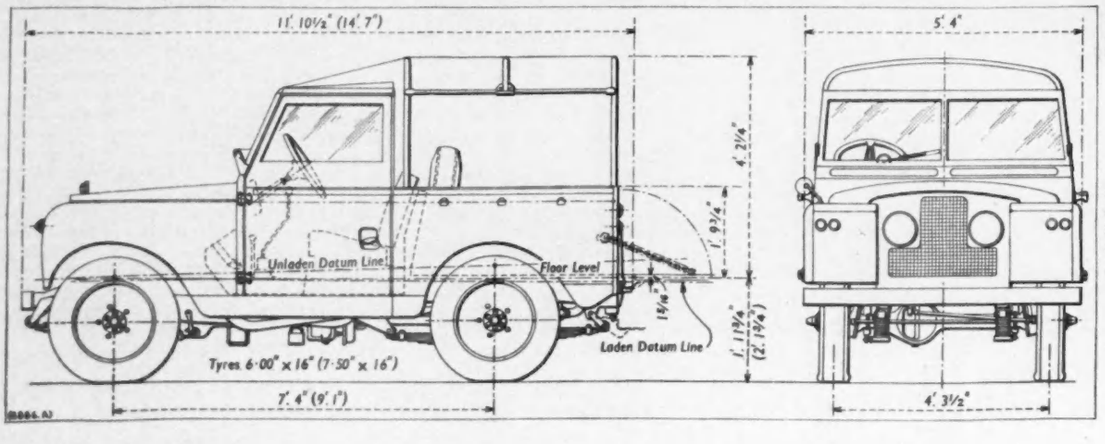


Fig. 2 (left) The Series II Regular Land Rover in standard trim. Figures in brackets refer to the Long Land Rover.

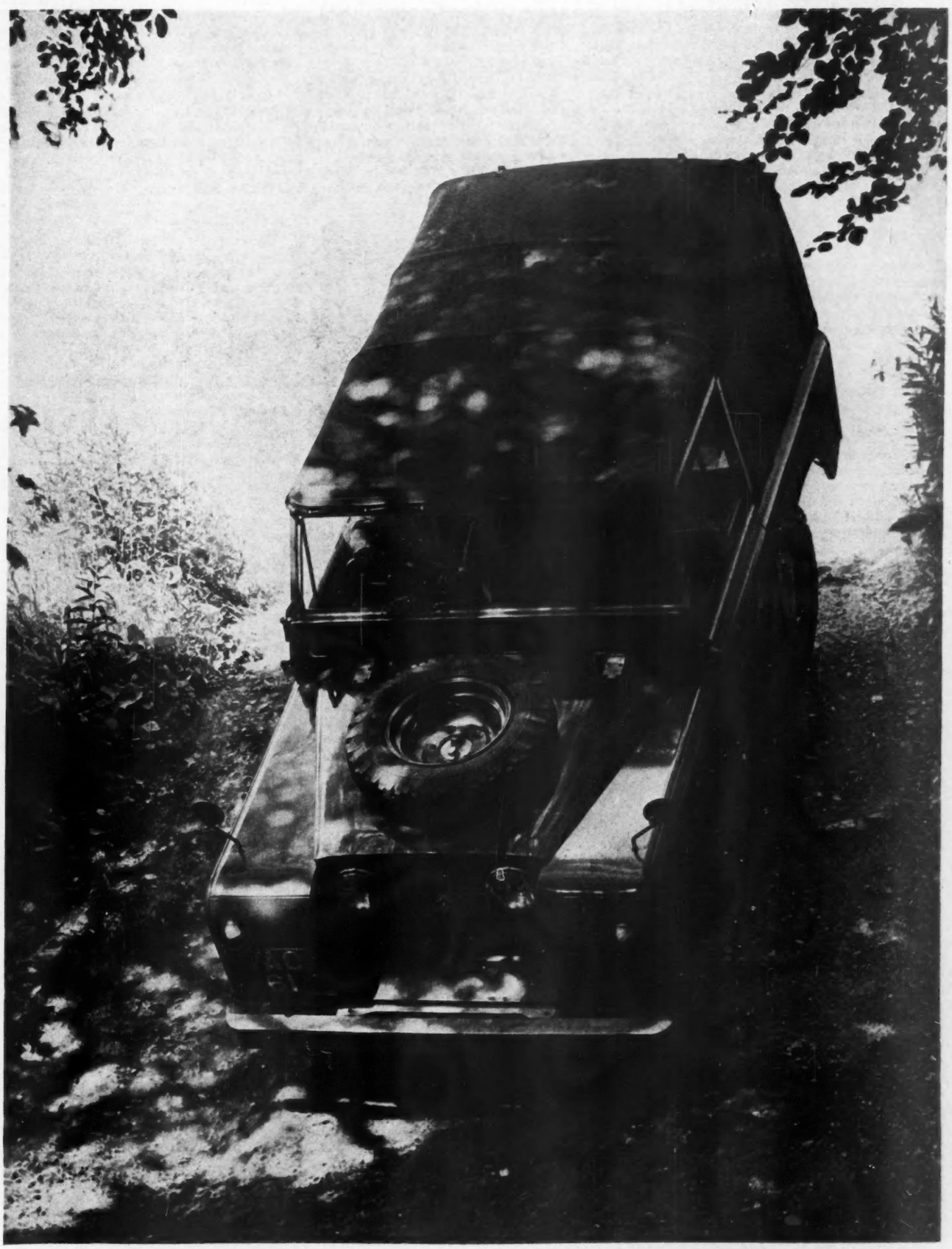


Fig. 3 Alongside the mass market there is also the specialist market. Hence the Land Rover.

by a new 4-cylinder 2¼ litre. This gave still more power, and was designed specially for the Land Rover so that the same cylinder block as for the 2-litre diesel engine could be utilised. The cylinder liners and crankshaft were, of course, made heavier in the diesel engine. The previous petrol engines had overhead inlet valves and side exhaust valves, but the new 2¼ litre was provided with in-line overhead inlet and exhaust valves.

Engines

One of the problems that had to be overcome when designing a diesel engine suitable for the Land Rover as an alternative to the petrol engine was that of matching the speed range so that the same gearbox and transmission could be used.

In order to run the diesel engine at a sufficiently high speed, indirect injection was adopted using the Ricardo Comet V combustion chamber. In this design fuel is sprayed into the hottest zone of compressed air in the chamber when the engine is started from cold, and is directed tangentially into the air swirl for normal running. This system of combustion provides smooth running at high and low speeds, combined with efficient combustion for maximum economy.

These qualities are emphasised by the use of a CAV type DPA fuel injection pump, which has an all-speed mechanical governor and is mounted in the equivalent position to the electrical distributor on the petrol engine. Direct interchange between diesel and petrol engines on the same vehicle is therefore possible, although with the diesel engine stronger front springs are required. Ratings are 77 b.h.p. at 4,250 r.p.m. for the petrol engine, and 51·2 b.h.p. at 3,500 r.p.m. for the diesel.

The transmission is essentially simple, comprising a conventional four-speed main gearbox and a hydraulically-actuated single dry plate clutch. In addition to the normal gearbox is a very important attribute known as the "transfer box" (Fig. 4). This forms part of the gearbox unit and has the effect of increasing the gear ratio at will throughout the normal range of four forward speeds and one reverse. Thus, in effect, eight forward speeds and two reverse are available, although selection of "low transfer," as the high ratio is termed, can only be made when the Land Rover is stationary. Its purpose is to give increased tractive power with reduced speed for difficult ground conditions.

Performance

Top speed of the Land Rover is quoted as 67·5 m.p.h. for the petrol-engined version and 52·5 to 59 m.p.h. for the diesel. Normal payload varies from 3 persons plus 1,000 lb for the Regular Land Rover to 3 persons plus 2,000 lb for the Long. These figures only apply to normal road usage and the Rover Company specify a reduction of 200 lb in the payload when used cross-country, except in the case of the Regular model when fitted with special high rate springs.

Considering its capabilities, fuel consumption is not excessive. Using the Regular model for comparison purposes, the approximate figures are 14 to 20 m.p.g. for the petrol version and 21 to 30 m.p.g. for diesel. The lower figures relate to contractors' and agricultural usage where for much of the time operation is over the worst type of ground.

Fig. 5 Long Land Rover in its standard form.

Frame, Suspension and Body

The chassis frame is exceptionally sturdy and is built up from box sections fabricated from flat steel plates, using a continuous arc welding process. To suit arduous operating conditions, long semi-elliptical springs are fitted, in combination with telescopic hydraulic shock absorbers front and rear.

Rigidity and corner protection for the aluminium body are provided by galvanised steel strips riveted on externally, which help to give the Land Rover its characteristic appearance. Spot welding is used throughout the bodywork, which is bolted to the steel chassis. There are three seats in the driving compartment, and the doors are sealed watertight for running through deep water as also are the engine and gearbox.

In "standard trim," as it is known, the Regular model is provided with a functional weatherproof canvas hood. A popular variation on the Regular model is an aluminium truck cab, giving a totally enclosed driving compartment, and this feature is standard on the Long Land Rover. Also popular is the detachable overall hard top, which is interchangeable with the full-length canvas hood. A further state of enclosure is the station wagon body (Fig. 7).

Many special-use forms of the Land Rover have been developed as the car's potential has been more fully realised, using equipment made and fitted by specialist contractors. Among the fittings available may be mentioned those for fire fighting (Fig. 6), agricultural duties (hydraulic lift and three point linkage for tractor-hauled implements), welding and workshop equipment, compressor and air tools, pumping equipment and vacuum brake trailer equipment.

In many cases owners of Land Rovers have become diehard enthusiasts to an extent more usually associated with veteran, vintage and sports cars. The Land Rover Owners Club with its headquarters at Solihull now has a membership of over 700. A measure of success and popularity of "that grand little vehicle," as one owner put it, is that when several users were invited by ENGINEERING to make suggestions for possible improvements, none of them could do so, except for minor matters.

Civil engineering contractors now form an important section of the user community; take the case of Higgs and Hill Limited, one of the main contractors on the Maidenhead Bypass road construction. They use five diesel-engined Land Rovers about their 2½-mile long site. Apart from the economy there are two other reasons why they prefer the diesel-engined version: firstly because there are no starting troubles although the vehicles stand in the open in all weathers; and secondly because much of the other plant on site uses the same fuel.

What of the future? With production continually increasing to keep pace with demand and with such a universally popular design, it might seem that no improvements are contemplated. Such, however, is not the case.

Close to Rover's factory at Solihull is a test course known as "the jungle." On this every Land Rover which incorporates any modification, however small, is thoroughly tested. The jungle contains every hazard likely to be encountered, with stuffed wild animals thrown in for good measure.

Apart from the unceasing research on components, a study is also being made at the present time of the possibility of introducing a forward control cab to the Land Rover.

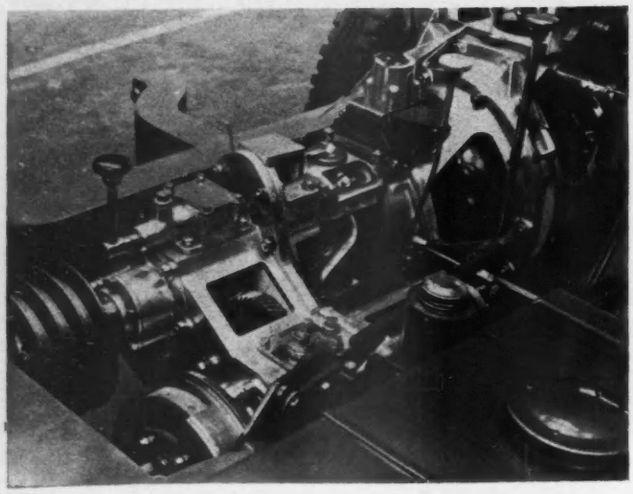


Fig. 4 (left) Cutaway of the clutch, main gearbox and transfer box, with grooved pulley on power take-off.

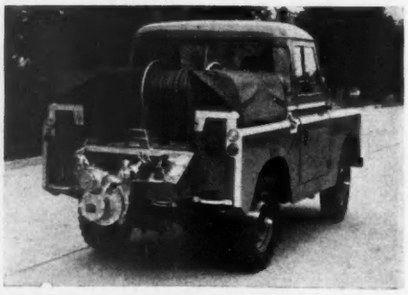


Fig. 6 (top right) Fire engine version of the Regular model.

Fig. 7 (bottom right) Station wagon version, showing opening for optional power take off at rear of chassis.

Inter-Relations of Clay, Oil and Water

Crude oil in a reservoir rock is well defined, but less is known of the conditions of hydrocarbons in a source rock, particularly those which ultimately accumulate as an oil pool. It is not known, for instance, whether they are present as minute free globules or in some quite different form. As an approach to this problem, research work is now in progress at the Royal School of Mines, Imperial College, London, on the inter-relations of clay, oil and water.

In the light of present knowledge, experiments in which a crude oil is used cannot be relied upon to duplicate the conditions in a source rock, but they may provide data to support or condemn the hypothesis that the oil is present in the source rock as finely disseminated oil globules. Moreover, the data obtained may also be relevant to situations where crude oil is brought into contact with water and clay-like material, e.g., in mud volcanoes, or where oil enters drilling mud during the drilling of a well, or escapes into muddy waters.

Qualitative studies have shown that various clays behave differently when they are dried at 105° C, mixed with crude oil, and finally added to fresh or salt water. Thus, Kaolinite, calcium montmorillonite and a sample of Gault clay remained closely associated with the oil, but bentonite showed almost immediate breakdown of the clay-oil mixture, releasing oil globules and giving a clay-in-water dispersion. Bentonite which had been heated to 400° C behaved in the same way as the other dried clays.

The same clays showed somewhat different behaviour when put in contact with fresh or salt water before mixing with crude oil prior to being added to a larger volume of water. Bentonite revealed little tendency to hold the oil. Calcium montmorillonite retained much of the oil, and that which escaped lacked spherical form and was fibrous or film-like; it failed to coalesce into a homogenous layer even after six months, presumably because clay particles were associated with the fibres or films. The Gault clay and kaolinite appeared to have the same effect in preventing coalescence.

When fine dispersions of oil in water were mixed with aqueous clay suspensions, the sedimenting clay carried down the oil completely. In the case of Gault clay, subsequent shaking with benzine apparently extracted all the oil.

Breakdown of Electrical Insulators

When studying the properties of electrical insulation, it is important to subject that insulation to the most onerous conditions expected in practice. Such conditions are usually those imposed by lightning or switching surges. Surges of this sort are best simulated in the laboratory by using a high voltage impulse generator.

It is also important to the engineer to know what ultimate dielectric strength he can expect to attain; he needs a quantitative knowledge of what has been called the intrinsic strength of the material.

In a recently published US Government paper, in which a current research programme of this nature is described, it is pointed out that the impulse generator possesses great utility for breakdown studies, since it can be used to obtain values of dielectric strength that approximate to the intrinsic strength. Immediately suggesting themselves in relation to impulse breakdown are several questions that merit research study.

One of these questions concerns the effect on an insulating material of repeated impulses at a voltage gradient insufficient to cause breakdown on application of a single impulse. A second question of interest concerns the possible existence in a solid dielectric of a relationship between breakdown gradient and time-lag of breakdown, such as has been found with liquids. A third question concerns the influence of specimen thickness on the relationship between breakdown gradient and time-lag of breakdown.

Under favourable circumstances, microscopic measurements can yield information concerning the relevent microscopic phenomena. This suggests the additional possibility that an engineering study of impulse breakdown in dielectrics, designed to answer the foregoing questions, may also yield a clue as to the nature of the mechanism of breakdown.

In this study, as in all breakdown studies, the inability to reproduce results from specimen to specimen presents the necessity for employing statistical considerations in the design of the tests, and in analysing the results. Part of the report is therefore devoted to statistical procedures of this nature.

One outgrowth of this phase of the work reported is an empirically derived mathematical model of impulse-breakdown gradient of the dielectric as a function of thickness of specimen and time lag of breakdown.

The choice of polythene as the material to be investigated in this study was based partly on its importance in modern applications, partly on its interesting electrical properties, and partly on the fact that it is a thermoplastic, with a consequent ability to flow under appropriate conditions of temperature and pressure. This last mentioned property makes it easily possible to achieve intimacy of contact between the specimen and the electrodes—a highly important consideration in breakdown studies.

Stereoscopic Camera Range Finder

A new type of stereoscopic camera rangefinder, which simplifies and increases accuracy in focusing, has been developed by a research engineer at the Fighting Vehicles Research and Development Establishment, Chertsey, Surrey.

Known as the 3-D-3, it overcomes disadvantages existing in present types which generally use a system of bringing two superimposed images into register with one another. It will mean better photographs for industrial and other professional photographers, and it will undoubtedly find favour with many amateurs.

The new rangefinder shows three distances in three dimensions, in a realistic manner. The photographer looking through it sees three indicating marks at different distances from him in space. The central, or focusing point, looks like a spot invisibly supported in space with two illuminated rings, one beyond it and one in front of it. The centre spot indicates range, and the far and near circles the limits of the depth of field.

Among the advantages of the 3-D-3 are that it makes focusing on moving objects instantaneous and simple. It is viewed with both eyes and can be used easily by people wearing spectacles. As the focusing images are illuminated by a miniature battery, the rangefinder is also effective in poor light conditions.

It can be made in a variety of sizes to fit anything from a 35 mm camera to the larger types used for press or industrial photography.

The inventor's demonstration model shows how the lens is set at an angle to adjust range and give compensation for varying eye separations. It is moved by a cam on the range knob, which can be seen above the button switch.

Radio Signals at Optical Frequencies

Coherent electromagnetic waveforms, which can be modulated with intelligence and transmitted, form the basis of radio communications. Usable frequencies have risen steadily over the years and have now reached the visible spectrum.

AN OPTICAL "maser" has been used in preliminary experiments in long-distance communications by research engineers at the Bell Telephone Laboratories in the USA. The device transmitted pulses of light between two points 25 miles apart.

The optical maser produces an intense and extremely narrow beam of light. With its narrow cone and frequency band, the beam is more than a million times brighter than the sun. With further developments such a beam might be used for communication purposes as well as in a variety of scientific and industrial applications. Apart from line-of-sight communications, either through open space or through "waveguides," the possibilities of optical radar are also being investigated.

The main feature of the optical maser is that it generates a beam of coherent light, that is, light in which there is a definite phase relationship from point to point in all parts of the beam. It is the property of coherence in radio waves which makes it possible to control, direct and modulate them. Therefore, by providing a source of coherent light, the optical maser indicates the possibility of extending present communication technology to the optical frequencies.

The heart of the Bell Laboratories' optical maser is a synthetic ruby rod, 1¼ in long and ⅛ in diameter. In the original experiments, the two ends were polished until extremely flat and parallel, then covered with a reflecting layer of silver, which was thin enough to be slightly transparent. This ruby rod was held in the centre of a spiral flashlamp and illuminated with an intense flash of ordinary white light.

THREE MAIN FACTORS

The investigators found that when the power applied to the flashlamp exceeded a certain value, a nearly parallel beam of light was emitted through the silvered ends. This light was red, like the ordinary fluorescent light from ruby, but differed from it in several important ways. First, it was sixty times closer to being monochromatic than the ordinary fluorescent light from ruby.

Secondly, the light was shown to be coherent, or of a single phase. This was demonstrated by arranging two fine, parallel slits in a thick silver coating on one end of a ruby rod. The pattern of emerging light showed that the light from one slit was "interfering" with the light from the other, indicating that the emitted light was in phase across the end of the rod.

Thirdly, almost all of this monochromatic light was emitted within a cone angle of only one-tenth degree. Within this cone, the intensity of the light was far higher than could be obtained by the ordinary fluorescent process.

In addition to these observations, the coherent light was found to be emitted in intense short bursts, each in the order of a millionth of a second long. With the present flash lamp, maser action could be sustained for about a thousandth of a second, during which several hundred of these bursts were observed.

In the communication experiments, a ruby optical maser was set up at the Holmdel, New Jersey, location of Bell Laboratories. The light emerging from it was directed at the Murray Hill laboratories, 25 miles away. The red flashes were clearly visible by naked eye, and registered on photomultiplier tubes. The circle illuminated by the beam at Murray Hill was only about 200 ft in diameter.

Experiments have also been conducted in which the pulses of light have been transmitted along a quarter mile of 2 in diameter circular waveguide where the dust and fog of the atmosphere would not attentuate the light beam. This waveguide had already been installed underground at Holmdel, for use in microwave and millimeter wave communication experiments. Photomultiplier tubes at the waveguide end recorded clear pulses of high intensity light.

At the present time messages can be sent only in a code based on repeated flashes. However, the fact that the coherent light is emitted in short bursts rather than as a smooth pulse shows that it may eventually be possible to modulate the signal so that many telephone conversations or television signals can be transmitted simultaneously over such a link.

Maser operation depends on the fact that all atomic and molecular systems possess discrete energy levels; i.e., they can store energy in fixed amounts or "quanta." These energy levels are different for each system. An atom in its lowest energy state can absorb energy from an electromagnetic wave of the right frequency and make a transition to an excited "upper" state. The atom can lose this energy in many ways. If it emits the energy as light, it can either emit a light quantum *spontaneously*, or it can be *stimulated* to radiate by a wave of similar frequency.

In the usual fluorescence of ruby, the chromium atoms in the ruby emit light spontaneously. The optical maser makes use of "stimulated" emission: in fact, its name is made from the initial letters of Microwave Amplification by Stimulated Emission of Radiation. A maser is so operated that more of the atoms in the material are excited to the upper state than remain in the lower state. A light wave of the proper frequency stimulates these excited atoms to emit their excess energy, thus gaining energy itself. The stimulated emission is in phase with the original wave, and so is coherent with it.

The basic concepts of the optical maser demonstrated were disclosed by A. L. Schawlow and C. H. Townes in a paper published in *Physical Review* in December, 1958, as well as in a recently issued US patent. The authors proposed extending the maser principle, from the microwave frequencies at which it first operated to the much higher frequencies of the infrared and visible light spectrum.

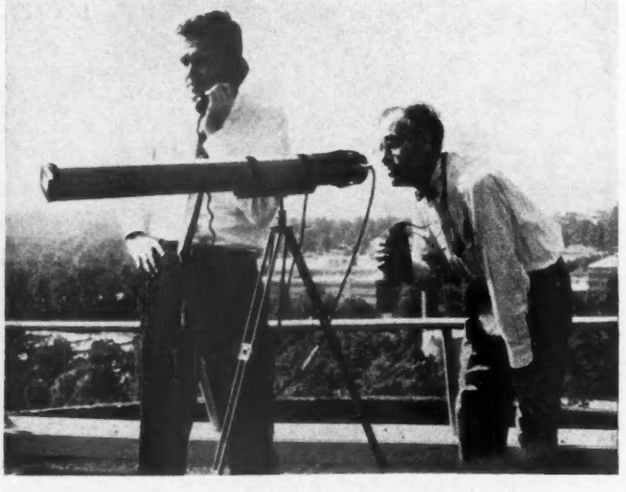
HIGHLY DIRECTIONAL

In the Schawlow-Townes maser configuration, a wave travels back and forth between the end plates, gaining energy on each trip. Only those waves travelling along the axis will be built up. All other modes will miss the end plates, and spend little time in the active medium. Since the end plates are small in comparison with the distance separating them, only the waves travelling accurately along the axis are amplified. This accounts for the high directionality—the lack of spreading—of the emerging beam. In order to understand the operation of the optical maser, it is first necessary to understand the phenomenon of fluoresence. A fluorescent material is one which, on exposure to light of some frequency or band af frequencies, emits light of a different frequency. The frequency of the emitted light is almost always lower than that of the exciting light. The coating on the inside of a fluorescent lamp, for example, accepts ultraviolet light and gives out lower frequency visible light. Similarly, when a sample of ruby is illuminated with green light, it emits red light that is of a fairly sharply defined lower frequency.

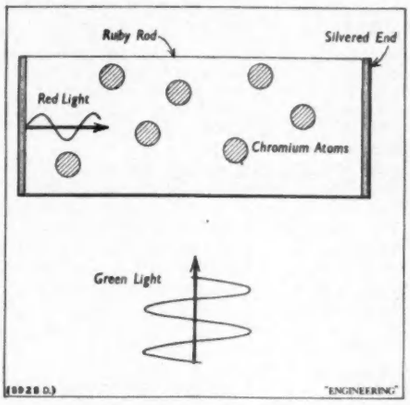
Ruby is crystalline aluminium oxide, with a small fraction of the aluminium atoms replaced by chromium atoms. These chromium atoms are the source of its red fluorescence.

The optical behaviour of atoms can be described in terms of the different amounts of energy, or "energy levels," which the atoms can possess. An atom at rest cannot store energy in continuously variable amounts, it can exist only in one of a well-defined set of energy levels. Ordin-

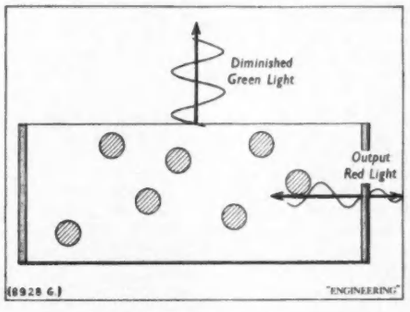
(Left) At the Holmdel location of Bell Telephone Laboratories, the optical maser was carefully lined up and then "fired."



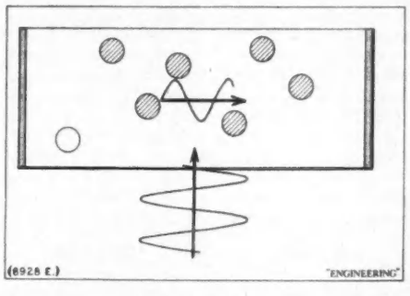
(Right) At Murray Hill, 25 miles away from Holmdel, the flashes from the optical maser were clearly received on a phototube detector.



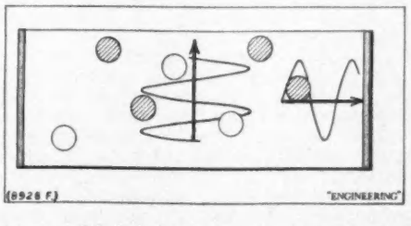
The output frequency band has been reduced by a factor of 60 over the usual fluorescence of ruby. Further experiments are expected to produce much greater narrowing factors.



In the optical maser, a ruby rod presents chromium atoms (shown by circles) to an oncoming wave of red light. The chromium atoms have been put into an excited state by green "pumping" light (indicated by shading the circles).



As the oncoming red light passes an excited chromium atom it may stimulate that atom to emit its excess energy as red light, and thus amplify the oncoming wave. The atom is then left in its lowest energy state (shown by the open circle).



The amplified light wave stimulates emission from other excited chromium atoms with increasing effectiveness. But in any one passage through the rod it cannot stimulate emission from all the excited atoms.

arily an atom will have the lowest of the possible energy levels. It can be raised to a higher level by absorbing light, and from that "excited state" it can jump back to a lower level by emitting light.

However, just as the atoms exist only in discrete energy levels, they will respond only to light of specific frequencies. There is a close correspondence between these critical frequencies and an atom's possible energy levels. Each frequency is proportional to the difference in energy between two of the levels. When an atom is illuminated with light having one of its critical frequencies, it will absorb a "quantum" of that light and jump to a higher level. When it relaxes to a lower level, it may emit light. If it does, it will emit a quantum of light of the appropriate frequency.

In the usual fluorescence of ruby, light in the green region excites some of the chromium atoms in the ruby to one of their higher energy levels. The atoms rapidly relax to an intermediate level, but one still above the original lowest level. Then, somewhat more slowly, the atoms relax from the intermediate level to the lowest level, emitting a quanta of red light in the process. The frequency of the red light is lower than that of the green light which originally excited the atoms, because the energy difference in the second jump down is less than the energy difference in their original jump up.

The level from which the chromium atoms take their second jump down, emitting red light, is often called "metastable" because the atoms are more reluctant to leave it than they were to leave the higher level to which they were originally excited. They eventually do leave it, however, and thus provide the red light observed in the ordinary fluorescence of ruby.

The optical maser uses the fact that the atoms can be stimulated to make the last jump more readily. The stimulated emission occurs when the atoms are bathed in light at a frequency similar to that which they wish to emit. The stimulated emission of light, in contrast to the spontaneous emission of light, distinguishes the action of the maser from ordinary fluorescence.

In the optical maser the atoms are excited to higher energy levels by the green components of the light from the flash lamp. From there they rapidly drop to a metastable level without radiating light. Spontaneous emission from that level is relatively slow, but the light given off by the few spontaneously emitting atoms is of the proper frequency to stimulate emission by the rest. Trapping some of the spontaneously emitted light by the two silvered ends of the ruby rod gives that light maximum opportunity to stimulate emission from the metastable atoms. An intense radiation is built up and continues as long as the population of atoms in the metastable state is constantly restored by "pumping" the atoms back up by green light.

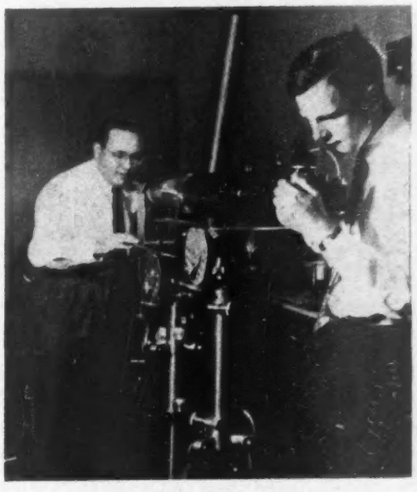
Only the light which makes many passes back and forth through the ruby rod stays in it long enough to accomplish much stimulation. Since the stimulated light moves in the same direction as the stimulating light, the only light which is strongly amplified is that which moves perpendicular to the mirrors, or parallel to the axis of the rod. For this reason, the output beam which leaks through the mirrors has almost all of its intensity in a very narrow beam.

The fact that the stimulated light moves in the same direction as the stimulating light is one evidence of the "cooperative behaviour" of the atoms in the action of the maser. This cooperative behaviour is responsible for the second important property of the emitted light, its coherence. Since light is an electromagnetic wave, it has many properties in common with other waves, and can be thought of in terms of a procession of crests and troughs, like waves on the surface of water.

An isolated atom, emitting a quantum of light, behaves like a pebble dropped into the water: a wave proceeds outward in all directions. Uncooperating atoms emit waves like those produced by many pebbles, dropping into the water at random places and at random times. The resulting disturbance is *incoherent*. This is the character of all ordinary light, including the fluorescent light usually given off by ruby.

In the maser, on the other hand, the atoms cooperate in such a way as pebbles would if the crests and troughs in the waves from all the pebbles reinforced one another. Pebbles dropped at exactly the same place at just the right rate, for example, would produce such a coherent wavelike disturbance. The control over coherence in light which is accomplished by the maser has not been available hitherto.

The third significant observation is the fact that the light from the maser is much more nearly monochromatic than the usual fluorescence of ruby. This narrowing of the band of frequencies emitted is an expected result of stimulated emission. Emission can be stimulated by light of slightly different frequency from the central frequency expected, but stimulation by the central frequency is most effective in returning atoms in the metastable state to the lowest energy level. Furthermore, in dropping to that level,



In order to stimulate maximum emission, the light wave is made to pass back and forth in the rod by reflection from the silvered ends.

the atoms emit more light at the central frequency than at other frequencies.

Thus, the intensities in the band of frequencies put out are more sharply peaked around the central frequency. At present, Bell Laboratories scientists have narrowed the band by a factor of 60 over the usual fluorescence band of ruby and they expect to achieve much larger narrowing factors soon.

In its present form, the maser emits light in closely-spaced short bursts. Each burst is less than a millionth of a second long, and the bursts are spaced only a few millionths of a second apart.

Bell research workers have said that one way in which they might explain this behaviour is as follows. The intensity of the light confined within the rod may tend to build up to the point where it stimulates emission. It begins to depopulate the metastable state so rapidly that the green light of the exciting lamp is no longer able to maintain a sufficient population of atoms in that state for the cooperative action of the atoms to continue. Then the radiation abruptly dies down, until the exciting lamp can restore that population. The extremely rapid pulsing of the light thus results from the alternating depletion and restoration of the active population of atoms.

Now that the favourable properties of ruby have been revealed, research teams are actively exploring the means for extending the techniques of modulation, amplification and detection, long exploited in radio communication, to the much higher frequencies of the radiation from the optical maser.

On the Shelf

By Frank H. Smith

I DON'T know how you are about these things but I sometimes get a bit confused about how to address foreign correspondents. One is pretty safe with the Monsieurs and the Herren but I am a bit shaky with the Senor and the Signor and when it comes to Dutch and Scandinavian I usually fall back on complete ignorance and plump for Mr. or Esq. Even with the American I am not too happy about putting Mr., which is what I believe their custom is rather than Esq. Thus it came as a bit of a smile when I had a circular from a French firm who addressed me as Sr. It may have been a typist's misfinger of course, but there *was* a breath of romance and hacienda about it.

Those who have followed the fortunes of the classification research being carried out under Cyril Cleverdon's eye at Cranfield may have wondered where the money came from. An idea may be gained from *Scientific Information Notes* of the National Science Foundation, Washington 25, D.C. I have only just seen a copy (volume 2, number 4, as a matter of fact) but it seems to be full of invitations for ideas in library and information research with hints that the required cash might be forthcoming. And incidentally, the *Report on the first stage of an investigation into the comparative efficiency of indexing systems* by Cleverdon is now available. Although the copy I have gives no indication of the fact, I understand that you can get copies from Aslib (3 Belgrave Square, London, SW1) at 10*s*.

A useful thing to have about the house is the Cambridge University Press list of journals which they publish (from Bentley House, 200 Euston Road, London, NW1, and 32 East 57th Street, New York 22). Particularly useful is the appended check list of the overseas journals obtainable from them.

Thanks to the hawk eye of one of the Hawker Siddeley library types, I am able to abase myself with a correction about a note on the article, "How to Cope with Information," which appeared in *Fortune* (this column, page 588). The month should have been September, not June as I said. For Pete's sake don't come at me with claims for postage refunds.

In the UNESCO *Monthly Bulletin* for September, I came across a mention of Pergamon's *Conference on Hyperconjugation* (35*s*). Now hyperconjugation is something about which I am quite ignorant—I do not even know what the *word* means. So I read the UNESCO comment very carefully. It was "The papers read stress various aspects of this growing and vital science, while the discussions that followed them stress the diverse nature of the evidence pertaining to hyperconjugation and the present flexible lines of approach to this science by workers in this field." From this I gather that hyperconjugation is something done by peasants with spades but I am still not too sure. More helpful is the item in the same bulletin on the system by which the index to *Physikalische Berichte* is prepared by punched cards. This is much the same as that described in *Fortune* for September which I have already mentioned.

Dunod (92 rue Bonaparte, Paris 6e) informs me that publié the début of Septembre his catalogue 1960-61. He offers l'adresser gratuitement the extracts of that catalogue susceptible of me to interest and suggests I return the card here joined completed and stamped. You send your own card.

The *Daily Telegraph* recently carried a large advertisement: "39 good reasons why you should buy a Renault Dauphine NOW." On the facing page was a news item that premium rates for insurance of the Dauphine had been raised 25 per cent, due to claims for this car proving abnormally high. This was not among the 39 good reasons.

Automatic Handling and Assembly

Automating the Manufacturing Process. By GEORGE F. HAWLEY. *Reinhold, New York; Chapman and Hall, London.* (40*s*)

Much has been written both at popular and scientific levels on the subject of automation. The industrialist is consequently aware that he has at his disposal a large number of relatively new techniques with which he is told that the prosperity of his industry can be increased—though, like everybody else, he may have little idea what automation means.

It would be unfair to the present generation of scientists to say that the aspects of automation which predominate in the present bibliography are those which can be most easily tackled analytically or on a general basis, regardless of the needs of industry. Nevertheless, it is true that some problems of considerable importance to the control of industrial processes have proved to be so bound up with the nature of the process that a general attack on them has been well nigh impossible.

Typical of the more intractable problems are those of automatic handling and automatic assembly, and the present textbook by George F. Hawley is a fair attempt to put these problems on to a proper basis so far as is possible. Although he does not try to analyse the subject in a general way, Mr. Hawley lays down the economic and engineering philosophies which must be practised when undertaking a project falling within this category.

The first chapters discuss the all important economic factors and how these must necessarily influence the scope of the project. Next the reader is introduced to typical projects in which the author goes through all relevant considerations, including technical proposals. The author stresses the importance of building models and deals with the design phases. The final chapters are devoted to the manufacture of the machine, installation and correcting faults.

The book is semi-popular and therefore quite readable. It is improbable that even the author would claim that his book tells the reader how to "automate" manufacture. There is no doubt, however, that it assists the promotion of a healthy state of mind in the engineer and tries with a fair amount of success to put forward the general philosophy he should adopt if he wants to make a success of commercialising his engineering ability in this field.

E. H. FROST-SMITH

Beyond the Billiard Ball

Reports on Progress in Physics, Volume XXII, 1959. Executive Editor A. C. STICKLAND. *The Physical Society, 1 Lowther Gardens, Prince Consort Road, London, SW7.* (63*s*, *Members* 21*s*)

The engineer must usually accept many interacting factors which complicate the application of the basic physical principles to the problem which he is posed. He hopes, nevertheless, that one day he will be capable of a precise description of the problem, but still the complexities of, for example, "simple" heat transfer to liquid flowing in a pipe can embarrass him. At times, in the past, he may have cast a jealous glance at the physicist who often seemed at liberty to select as his interest an isolated system free from such disturbances. Indeed he may also have lost patience with the pure scientist's interest in so miscalled "ideal systems," which he can describe but have little superficial relationship to those occurring practically.

Today, now that the satisfaction of the billiard ball era of physics is past, the critic is well advised to pause. The inadequacies of the old description are only too apparent but, despite the complexity of recent developments, there is a more exciting degree of coherence becoming apparent beneath. What is more valuable, the changing description is often valuably suggestive in many fields. Year by year, the Physical Society presents the *Reports on Progress in Physics* in which noted authorities are invited to review selected topics covering the ground of physical sciences.

The article on "Applications of Quantum Mechanics in Theoretical Chemistry" shows how diffuse is the border between physics and chemistry. Chemistry is a long way from becoming a branch of physics: despite successes, the wave equation, in general, is not soluble; the use of models can be severely limited as the precision of prediction can be lost with the simplification which makes the solution possible. The increasing use of computers offers help but the author is not excessively optimistic: "it seems unlikely that wave functions of reasonable accuracy will ever be calculated for molecules having three or more nuclei (other than H) and more than 25 electrons."

The second article reviews the whole field of "Progress in Vacuum Technology": pumps, trapping, measurement of speed, pressure measurement to very low pressures and leak detection. For years the physicist has disbelieved the capabilities of ejector pumps, but the author graciously acknowledges that it is unfortunate that the engineer and physicist have not come together sooner in this work.

The chapter on "Propogation of Elastic Waves in Crystals and Anisotropic Media" does not consider absorption in the medium but nevertheless must be of interest for those working on flaw detection and seismology. The review of "Physical Problems of Thermoelectricity" one of the three invited Russian contributions, illustrates how application of physical theory is providing new methods and materials; here the development of improved thermoelectric devices from semi-conductors. Of interest to the communications engineer is the "Experimental Investigation of the Ionospheric E-layer."

The catalogue of "Paramagnetic Resonance Data" is complete as far as work done up to the end of 1958. From a study of "Nuclear Magnetism in Pure Liquids" the effects of molecular motions in liquids and molecular effects due to electrons are discussed. The value of "Radiofrequency Spectroscopy of Excited Atoms" lies in its discrimination between the close lying energy levels. The other two Russian contributions are concerned with "Experimental Work with ^3He" and "The Theory of a Fermi Liquid" to which class liquid helium 3 and electrons in metals belong.

A chapter reviews the possibility of "Double Beta Decay" and what this would mean from present understanding of fundamental particles. Interest in the symmetries observed in nuclear process has been heightened by the fact that they are not universal—the surprise that parity is not conserved. These symmetries are reviewed in the chapter on "Invariance in Elementary Particle Physics." That article is difficult to try to follow but the introduction to the final section on "The Two Nuclear Interaction" is more daunting. One reads that the chapter on "Phenomenology" is meant to be intelligible to any reader with a working knowledge of quantum mechanics and the chapter on meson field presupposes a familiarity with modern (post 1949) field theory. Considerately, paragraphs which should be more readily understandable by the general reader are indicated!

A topic of polite scientific conversation for the lay physicist is "Relativity." Bondi's article will help him straighten his thoughts and dis-

criminate between the principle of special relativity, applicable to observers having constant relative velocity, and the general theory, which seeks to allow translation of the laws describing natural behaviour from one coordinate system to another whatever their relative motion. In this, it is the unique character of the gravitational field which is one of the surprises of our experience.

Perhaps this Volume 22 is too heavy, in more ways than one, for holiday reading, even in the summer of 1960, but it offers much of interest. It is a long time before the mechanical and physical sciences will "come home" to their parent physics but it is stimulating to note the progress. "To follow knowledge, like a sinking star, beyond the utmost bound of human thought."

J. S. M. BOTTERILL

How the French Build Merchant Ships

Construction du Navire de Commerce. By EMMANUEL CHICOT. *Éditions Maritimes et Coloniales, 17 rue Jacob, Paris 6.* (32 *N Fr*)

In his foreword, Monsieur Ricard, who directs the technical service of the Compagnie Générale Transatlantique, introduces Monsieur Chicot as the chief of that firm's technical office in Paris. Since the Liberation M. Chicot has supervised from there the reconstruction of the French North Atlantic passenger fleet and the building of the new liner "France." He has also been responsible for many other diverse craft required for the company's passenger and cargo services to South, Central and North America, including the Great Lakes, and the cross-Mediterranean runs to Corsica, Morocco and Algeria.

Monsieur Ricard takes the opportunity of expressing concern that the New Convention for the Safety of Life at Sea of 1960 may add further difficulties to the shipowners, already burdened to an extent suffered by no other operators of passenger transport. Low down in the vessel the new engines are lighter and require less fuel, while aloft increasing demands for hotel services and private sanitation, make the provision of excess stability to cover accidental flooding a very difficult matter, even with the new aluminium alloy superstructures. If, he says, the idea of a fireproof unsinkable ship reduces the vigilance of her crew in lookout duty or, until the atomic ship arrives, in the adjusting of stability as double-bottom fuel is burnt, there will still be sea accidents.

This warning is to the pupils of the French navigation schools, for whom the book is intended, but much has been added with the purpose of making it a reference and textbook suitable for the student shipbuilder. In this aim it succeeds admirably.

In the text Monsieur Chicot assumes no previous knowledge of a ship, gives a simple description of its parts, and defines the size and volume characteristics from the lines plan, before illustrating by photographs, drawings and staistics, types from passenger liner to trawler which go to make up the French Merchant Navy.

The assessment of International Nett and Gross Tonnage is introduced by a historical survey from the British law of 1694 to that agreed at Oslo in 1947, with the modifications of 1954, which allow reduction for the new smaller engine spaces.

Under the heading "Security and Habitability" the author gives a very real service to his students, for he summarises and explains all those rules, regulations and laws which affect the French merchant ship. International items include: the Conventions for Load Line, Safety of Life at Sea, Crew Spaces and the Protection of Workers loading and unloading ships, while the French laws discussed apply to hull construction, sub-division, stability, machinery and auxiliaries, fire protection, life saving, navigation instruments and documents, electrical installations, radio, accommodation, hygiene, rat proofing and the transport of grain and dangerous goods.

There is an introduction to strengths of materials with the application to a ship on a wave, followed by a specification of the properties of the woods, metals and plastics used in construction and their connection to each other, including the insulation of dissimilar metals to prevent corrosion.

Alloys of aluminium with from 2½ to 5½ per cent of magnesium are permitted by the Bureau Veritas for superstructure above the strength deck, hatch covers, ventilation fittings, sidelights, windows and lifeboats, while the use of plastics has been extended and includes some piping, sanitary fittings and the hulls of lifeboats.

Standardisation controlled by the Association Francaise de Normalisation (AFNOR) has been adopted or proposed for rivets, bolts, pipe fittings, sidelights, windows, manholes, guard rails, rigging, derricks, blocks, sanitary fittings, mooring fittings, winches, steering gears, boats, scuppers, discharges, pumps, propeller shafting, ventilation heads and electrical fittings and many of these standards are illustrated in the text including the French pipe flange with its spigot and socket.

The steel hull, generally built to Bureau Veritas rules (although Lloyds Register and the American Bureau of Shipping are by the French law of 11 June, 1954, equally acceptable) is next considered in great detail for different types of vessel, including the wine tankers bringing the Algerian wines to France. The structure and fittings are illustrated by Monsieur M. C. Breitschmitt's drawings, which clearly label each part.

Rudders, steering gears, mooring, warping and towing gear, boats, masts and derricks, hatches, watertight doors, standard manholes and the Denny-Brown stabiliser are all described and well illustrated, as are the sections on piping systems, ventilation and electrical wiring.

Accommodation for both crew and passengers is always increasing in scope, and on the French North Atlantic routes the present tendency to provide private bathrooms to first class cabins is extending to at least a percentage of the other classes. Plans of sample cabins are shown, and other amenities such as public rooms, cinemas, swimming baths and laundries are discussed.

With his survey of the ship completed, Monsieur Chicot tells how the original design is prepared, the vessel mounted on the building slip, launching with a single or double launchway, followed by fitting out and sea trials.

A final chapter deals with the problems of the ship's officers, such as stowage, ballasting, cargo handling and upkeep to the standards of the Bureau Veritas and the French Ministry of Marine.

The inclusion of worked examples to the methods of calculation usual in English and unusual in French textbooks would give the French student an earlier confidence.

The index of one thousand items, the simple explanation of each new shipbuilding term as it appears, and the meticulous labelling of the smallest items in the two hundred illustrations make the book ideal for the foreigner requiring a knowledge of French shipbuilding nomenclature.

H. PECK

Redeploying Labour to Allow for Growth

The Attitudes of Steelworkers to Technical Change. By OLIVE BANKS. *Liverpool University Press, 123 Grove Street, Liverpool 7.* (25*s*)

Industry must continuously be concerned with incorporating technical developments and changes in order to maintain and improve its competitive efficiency. In the past, many companies need take no account of their workers' attitudes; high unemployment and a generally lower social conscience permitted this indifference. Today, the position is very different. Modern managements employing many thousands of workpeople and staff are concerned to gain the positive cooperation of their employees.

When contemplating new schemes involving the expenditure of millions of pounds, managements must ensure not only that workpeople do not obstruct the introduction of new ideas, methods and machinery but that they welcome them. If technical change is to be accelerated in the future, the social problems involved in transferring people from one job to another, or in retraining people to do similar jobs with more complex equipment, are considerable.

The steel industry has witnessed many technical changes in recent years and the changes in one company in North Wales have been the subject of two reports prepared by the Department of Social Science at Liverpool University. In the first of these reports, published in 1956 and reviewed in ENGINEERING in January, 1957, Mr. W. H. Scott describes the history of the family firm, its management's trade-union relations and discusses the problems concerned in the growth of the firm throughout this period. The object of this inquiry was to "assess how a particular structure influenced attitudes to a possible or impending change, and, once a change had been effected, to ascertain the consequent changes in structure and whether these in turn had modified attitudes to change."

In *The Attitude of Steelworkers to Technical Change*, a team of researchers led by Dr. Olive Banks, continued this study of workers' attitudes to technical change. The object of the latter study was to analyse in more detail the effect of "the replacement of two old melting shops by a single new shop . . . the construction of blast furnaces and coke ovens for the first time, and the establishment of maintenance ancillaries for all these units." This change had been initiated in 1952.

Dr. Banks and her team interviewed a sample of men, based mainly on wage experience and age, and sought answers to a wide range of questions relating to the way in which the firm informed people of the reasons for, and the nature of, the forthcoming changes and the effect that these changes had had on the people concerned; whether changes in work practices, remuneration or social habits. Further, a number of hypothetical questions were asked which sought to elicit individuals' views on more general matters in the event of the firm embarking on major capital schemes involving the laying-off of 500 men. The questionnaire which was devised for this purpose is included as an appendix to the book. It is very well designed and the resultant answers clearly presented in tabular and graphical form. The author has obviously taken great care to help the reader to absorb a great deal of statistical information on which her conclusions are based.

To summarise accurately Dr. Banks's con-

clusions is difficult in a study in which the author has shown great care in not arriving at too firm conclusions on too little evidence. The author's general conclusion is that the steelworkers "show no evidence of any widespread hostility to technical change as such, even among redundant workers or those whose earnings have decreased as a result of the change." In this case, however, the number of people suffering a considerable drop in earnings was so small as to make one wonder whether attitudes would have been different had the reverse been the case. For example, in the case of this steelworks, the introduction of technical change coincided with a major expansion of the works. Would there have been a more appreciable change in attitudes had the introduction of the new schemes resulted in the possibility of a substantial number of workers suffering a loss of £10 per week without the opportunity of transferring workers to new departments? It is also reassuring to see the opinion expressed that employees "are more adjustable" (in the wider social sense than the purely industrial one of doing a job) "than is supposed." These conclusions make extremely interesting reading and may well challenge many preconceived notions as to how individuals would respond to changing conditions. We know far too little about the attitudes of employees to technical change quite apart from why these attitudes are adopted.

While the steel industry was selected as the background for this study, the researchers were interested in the attitudes to technical change in general. To what extent can the conclusions from this study be related to other industries or, indeed, companies? Are steelworkers' attitudes different from those of other workpeople, for example, miners, railwaymen, or clerks? The answer is probably "yes" in so far as their attitudes are influenced by their industrial environment. The steel industry has experienced no major strikes during the past 30 years; this period has been one of continuous and, since the war, rapid expansion; redundancy has rarely been a problem in the industry generally (though it has at individual works); much of the unpleasant manual work and much of the guesswork is being eliminated; and the wages of steelworkers are high on the list of all industrial workers.

The combination of these factors plus the excellent cooperation between management and unions, which Dr. Banks so rightly stresses as being of great importance, are probably the main factors in the successful assimilation of technical change. In contemplating future changes, managements will need to improve and extend even more the system of communication between managements, trade unions and men.

Dr. Banks has produced an extremely interesting and useful report of her team's research. While one hopes that laymen will read this book, particularly the concluding chapter, much of *The Attitudes of Steelworkers to Technical Change* seems to be aimed at the sociologist or social scientist. The layman may find a less technical write-up of these conclusions in a comparative study of which the present volume was a part. This comparative report, in the preparation of which Dr. Banks participated, is entitled *Steel Workers and Technical Progress*, published by the European Productivity Agency.

It is to be hoped that the author of this present work will extend the range of her inquiries to an industry (preferably not steel) where technical change has not been effected as smoothly as in the particular firm described above. It would be interesting and probably fruitful to read something of the way in which people react in such industries as motor cars, railways and coal mining.

E. HOUGHTON
W. F. JONES

New Books

The Year Book of Technical Education and Careers in Industry, 1960. Edited by H. C. DENT. *A. and C. Black.* (35*s*)

Figures quoted in the latest edition of this directory show that some 40 per cent of the full-time students in the universities are engaged in science and technology, with a rather higher figure in major establishments of further education. Full details of educational establishments are supplemented by summaries of the opportunities in various branches of industry.

Transformers and Generators for Power Systems. By R. LANGLOIS-BERTHELOT. *Macdonald.* (65*s*)

Written for the engineering student with a general grounding in physics, the engineer concerned with design and manufacture, and the operating engineer. The text is divided into two parts, the first dealing with the transformer and the second with the synchronous machine.

Mechanical Engineering Craft Practice. By H. C. TOWN. *Chatto and Windus.* (16*s*)

Specially written for the apprentice taking the new City and Guilds course in Mechanical Engineering Craft Practice, and covering hand tools and bench operations, precision measurement, sheet metal working, drawing office practice, and the construction and operation of the principal types of machine tools.

The Federation of Civil Engineering Contractors: Handbook 1960-61. *The Federation, Tufton Street, London, SW1.* (12*s* 6*d*)

All the main Federation documents, including the Working Rule Agreement of the Civil Engineering Construction Conciliation Board, the ICE Conditions of Contract, and the Federation Dayworks Schedules, are contained in the Handbook, together with alphabetical and geographical lists of the Federation's 690 members.

A Geology for Engineers. By F. G. H. BLYTH. 4th edition. *Edward Arnold.* (30*s*)

The new edition includes discussions of permafrost, tidal surges in the North Sea, the geology of the Sasumua Dam and the Kariba Dam site, and the Folkestone Warren landslide, and a new chapter on methods of site investigation has been added.

Ingenious Mathematical Problems and Methods. By L. A. GRAHAM. *Dover, New York; Constable, London.* (11*s* 6*d*)

A collection of problems published over a period of years in the house journal of the author's engineering company, and contributed to by engineers from all over the USA.

Stabilization of Free Radicals at Low Temperatures. Edited by ARNOLD W. BASS and H. P. BROIDA. National Bureau of Standards Monograph 12. *US Government Printing Office, Washington, DC; HM Stationery Office, London.* (13*s* 6*d*)

At the Fourth International Symposium on Free Radical Stabilization held at Washington in 1959, the present papers were read, resulting from a three-year programme of research by the National Bureau of Standards.

Transistors: Circuits and Servicing. By B. R. A. BETTRIDGE. 2nd edition. *Trader Publishing Company.* (3*s*)

An account of the transistor and transistor circuits, with servicing hints and pitfalls, intended for the electronic service engineer. A simple test method is described.

Bergman's Linear Integral Operator Method in the Theory of Compressible Fluid Flow. By M. Z. v. KRZYWOBLOCKI. *Springer-Verlag, Mölkerbastei 5, Vienna 1.* (88*s* 6*d*)

The method developed by Stefan Bergman is scattered throughout many papers in mathematical journals; Professor von Krzywoblocki's purpose in the present work is to show the method in all its variations in such a way that the engineer or aerodynamicist may use it in practical applications.

General Dynamics of Vibrations. By Y. ROCARD. *Crosby Lockwood.* (80*s*)

Translated from the third French edition, Professor Rocard's text gives a very comprehensive coverage of a field which has more often been tackled from a more narrowly specialised point of view, and one of equal value to the mathematician, the physicist and the electronic engineer.

Manchester Association of Engineers: Transactions. Sessions 1956-57 and 1957-58. *The Association, 40 Brazennose Street, Manchester 2.* (21*s* each)

The two latest volumes to appear include papers on subjects closely associated with Manchester, among them those celebrating the centenary of the Association itself, and more general contributions on the production of motor cycles and the use of models in engineering.

Proceedings of the Symposium on Microminiaturisation of Electronic Assemblies, 1958. Edited by ELEANOR F. HORSEY and LAURENCE D. SHERGALIS. *Hayden Book Company, New York; Chapman and Hall, London.* (88*s*)

Papers presented covered techniques, semiconductors, components, circuits, missile systems and microelectronics in industry.

A Guide to the Principles of Costing in the European Non-Ferrous Metals Industry. *International Wrought Non-Ferrous Metals Council, 6 Bathurst Street, London, W2.* (16*s* 6*d*)

Following a meeting in Helsinki in 1956 a committee of experts was set up to develop the costing schemes in operation in the member countries of the Council, and at the same time provide a uniform basis to enable international cost comparisons to be carried out.

The Reviewers

Dr. E. H. Frost-Smith is director of research in the Stavely Research Department of the Stavely Coal and Iron Company Limited.

Dr. John S. M. Botterill is a lecturer in the Department of Chemical Engineering at the University of Birmingham. His academic training embraces both physics and chemical engineering, and he is an associate of the Institute of Physics and a member of the Society of Instrument Technology. From 1952 to 1955 he was a scientific officer with the Industrial Group of the United Kingdom Atomic Energy Authority at Springfields.

Mr. H. Peck is a leading ship draughtsman employed by Vickers-Armstrongs (Shipbuilders) Limited, Barrow-in-Furness. From 1923 to 1926 he served as ship draughtsman with the Ateliers et Chantiers de France, Dunkerque.

Mr. E. Houghton is assistant works manager (special duties) with Steel, Peech and Tozer, Rotherham.
Mr. W. F. Jones is organiser of staff courses in the United Steel Companies Limited, Sheffield.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Zinc-Rich Paint and Sealer. SECOMASTIC LTD., Western Road, Bracknell, Berks. Effectiveness of anodic protection given by zinc-rich paints is enhanced by a sealer coat containing micaceous iron ore. 4 pp., ill.

Polyester Fibres. IMPERIAL CHEMICAL INDUSTRIES LTD., Harrogate, Yorks. Industrial buyer's guide to Terylene has just been completely revised. Now comes in 7 parts. About 45 pp. in all, unill.

Cast Iron. INTERNATIONAL MEEHANITE METAL CO. LTD., 4 Downside, Epsom, Surrey. Shows how to design castings in Meehanite cast iron so as to obtain a sound component at lowest cost and with best properties. 6 pp., ill.

Pitch Fibre Pipes. KEY ENGINEERING CO. LTD., Larkfield, nr. Maidstone, Kent. Introduction to pitch fibre as a useful material for drainage piping. 2 pp., ill.

Packing Materials. CRANE PACKING LTD., Slough, Bucks. Much thought on presentation of comprehensive data on gland packing materials makes this well worth obtaining. A few minutes should be spent on finding one's way around but data is of a lasting kind. 58 pp., ill.

Sprayed Asbestos. TURNERS ASBESTOS CEMENT CO. LTD., Trafford Park, Manchester 17. Where and how to use this material. 14 pp., ill.

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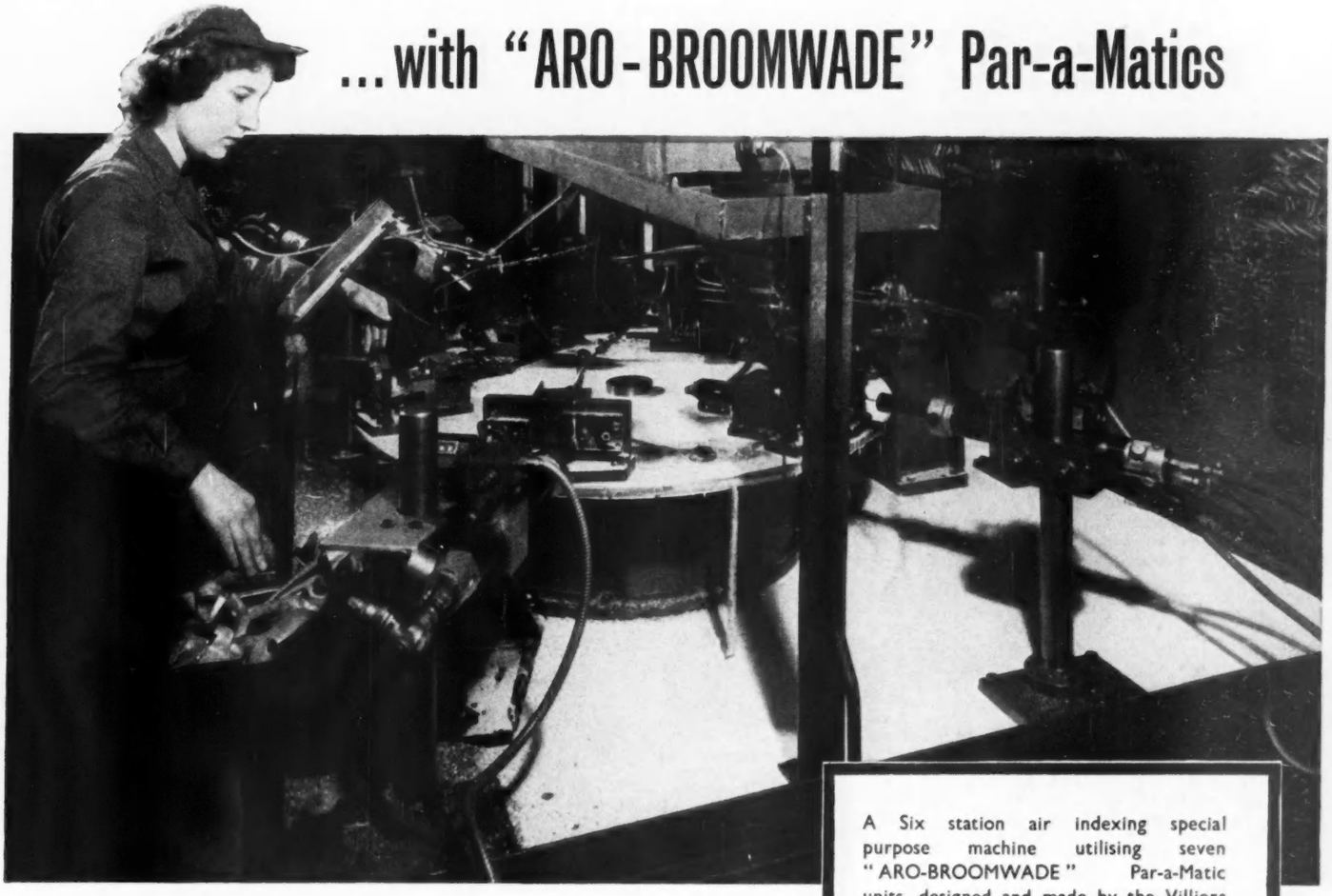

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5th Station ..	Tap 1 hole 6 BA.
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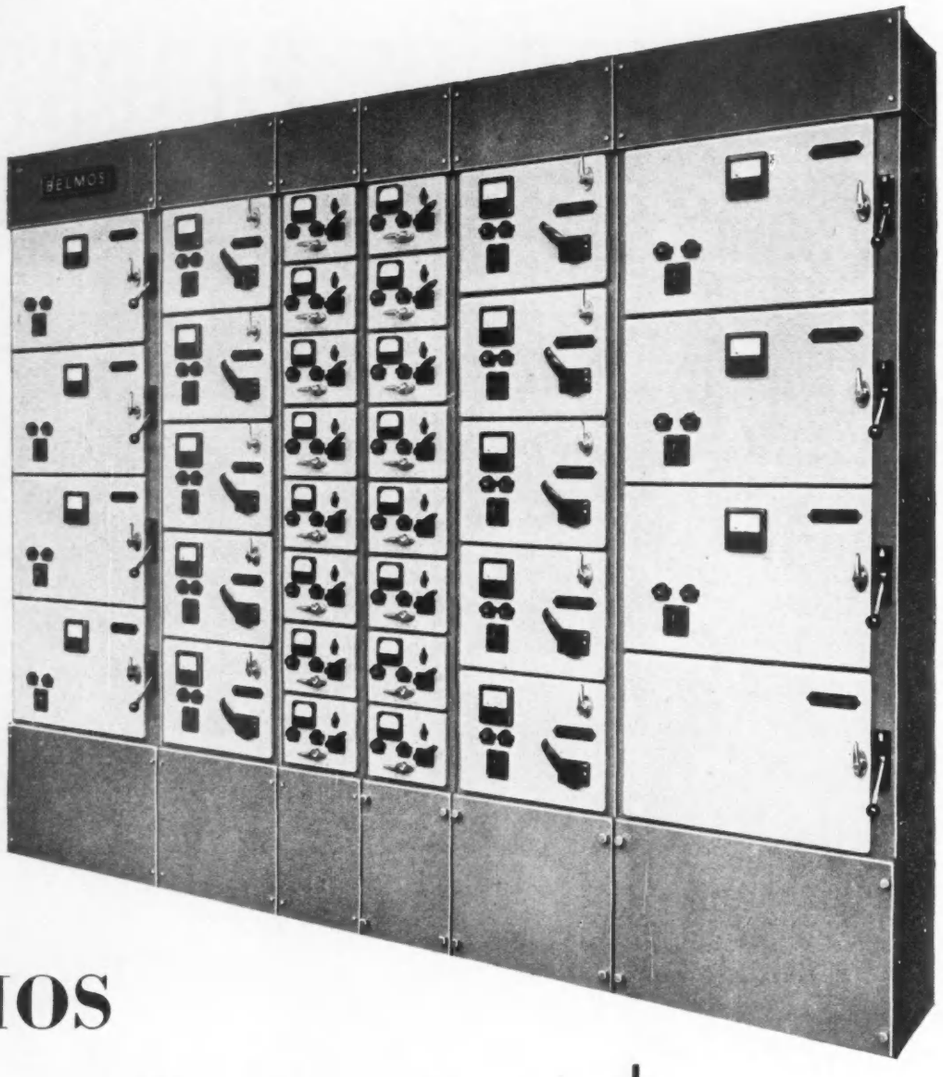

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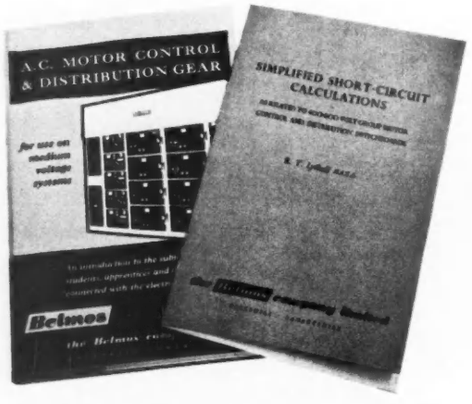

"A.C. Motor Control and Distribution Gear "
Describes the design of modern motor control gear and boards, industrial and flameproof. Includes sections on circuit diagrams, sequence and control circuitry, protection and short-circuit problems. 95 pages. 117 illus. Price 15/- post free.

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For non-mathematicians. The specially designed tables and explanations make it easy for everyone to assess fault values at low voltage with close accuracy. Worked examples with diagrams show how. 32 pages. 22 illus. Price 5/- post free.

Marketing

Paxman Alternator Sets Among the Polar Bears

DAVEY, PAXMAN & Company, of Colchester, the engineering firm associated with RUSTON & HORNSBY, have sent two of their 12-cylinder diesel-alternator sets to the Norwegian island Jan Mayen, in the Arctic ocean 400 miles north of Iceland.

The 35 miles long volcanic island, icebound for six months of the year, has a natural life confined to seals and polar bears. In addition there is a radio station, for which the Paxman sets are wanted.

The contract carried a penalty clause, since it was essential that the alternator sets should arrive while the waters are still navigable. In the event, the clause was not infringed. The specially packed alternator sets left Colchester last month and were sent off to Jan Mayen on the 600 ton Norwegian sealing boat, Polar Bjorn (Polar Bear).

Through the long winter electrical power is needed 24 hours a day for lighting and heating. The 230 volt, 3 phase, 50 cycle supply has so far been maintained by four 85 kW diesel-alternator sets, one used as a standby unit.

In the new system, the existing sets will be supplemented by the more powerful Paxman units. These have a 7 in bore by 7¼ in stroke, four cycle, 12 cylinder, vee form diesel engine solidly coupled to a flange mounted AEI 252 kW drip-proof alternator wound for 230 volt, 3 phase, 50 cycle supply. The standard continuous output of each engine at 1,000 r.p.m. is 400 b.h.p.

The two sets had been built, tested and put aboard, within two months of the order being placed by KOLBERG & SANNE, the Norwegian agents of Davey, Paxman.

£A500 million Road Plans for Australian State

A programme of road improvements in the state of New South Wales, Australia, which would cost £A500 million over the next ten years, has been described by the Minister for Local Government and Highways, Mr. Hills.

Inauguration of the scheme by the New South Wales Government would fit the programme into the general Australian road improvement effort. The state plans involve investing more than £A450 million on improving 12,000 miles of roads and £A50 million on surfacing some 2,500 miles of unmade road.

Indian Repeat Order For Leyland Comets

The Nagarjunasagar Dam project on the river Krishna, in India, is the scene of operations by more than 100 Comet trucks built by LEYLAND MOTORS Limited.

When the project is complete two million acres of land will be irrigated in the state of Andhra Pradesh. Behind the dam will be the third largest artificial lake in the world. Food production will be raised by 800,000 tons a year and there will be employment at the peak period for 123,000 people.

The great Nagarjunasagar dam will need 214 million cu. ft of masonry, concrete and earth before it is finally completed, by the end of India's third five year plan.

Satisfactory operation by the fleet of Comets now working on the project has led to an order for another 25 from Leyland's Madras associate company, ASHOK LEYLAND.

Light Plane Engines USA-RR Agreementt

Entering the field of light aircraft as producers of their engines, ROLLS-ROYCE have completed a licence agreement with the CONTINENTAL MOTORS Corporation of Muskegon, Michigan, USA, covering the full range of Continental's aircraft piston engines.

The licence allows Rolls-Royce to provide the complete range of engines, spare parts and a full after-sales service. The company also gain exclusive rights in Europe for Continental piston engines and spares and for Rolls-Royce built Continental engines in Australia and New Zealand.

Where Rolls-Royce foresee a sufficient market for any one of the Continental engines they will establish production facilities. While production capacity is being established in Britain Continental engines will be delivered through Rolls-Royce.

A new Rolls-Royce department—Light Aircraft Engines—has been set up, under the leadership of Mr. J. P. Herriot, who joined Rolls-Royce in 1945 as chief development engineer on the early Whittle jet engines. For several years he was manager of the company's licence department. As such he was responsible for the operation of Rolls-Royce licences in many parts of the world.

For two years past Mr. Herriot, a founder member of the Gas Turbine Collaboration committee, has been with the International Division of Rolls-Royce, doing world-wide market research on the future for light aircraft with a particular eye on the engine position.

Continental's piston engines are air-cooled horizontally opposed four and six cylinder units. Their power range is from 65 to 400 h.p. In the United States and other countries where light aviation has developed.

New Ferodo Works For North Wales

FERODO, the brake lining manufacturers, have taken an important further step towards establishing a new friction materials factory in North Wales on the bank of the Menai Strait. The company is about to complete its purchase of a 50 acre site two miles from Caernarvon and seven from Bangor.

Since the unemployment percentage in Caernarvon is 6·5 and in Anglesey 9 (against a national average of 1·5 and 2·4 in Wales) the project has the support of the Board of Trade. The industrial development of the land has been approved.

The 240,000 sq. ft factory will be close to the Snowdonia National Park and overlooked from Anglesey. For these reasons Ferodo state that great care will be taken with design, selection of building materials and landscaping in order that the buildings shall harmonise with the surroundings.

The figure given for the area of the factory is the first stage, when it is expected to employ 500 people. Later developments may increase this to 1,000 employees.

Caernarvon and Anglesey have a combined unemployment total of 2,180 in the Ministry of Labour's mid-October returns.

No Steam Trains West of Newton Abbot

Contracts for 50 main line diesel locomotives and 98 sets of engines and transmissions for diesel shunting locomotives now being built in the British Railways workshops at Darlington and Horwich have been placed by the British Transport Commission.

The 50 main line locomotives, to be built by BEYER PEACOCK (HYMECK), are all intended for the Western Region. ENGLISH ELECTRIC are to make the 98 sets of power equipment, 41 for the Western Region, 40 for the London Midland and the rest for the Eastern, Scottish and Southern Regions. The work will be carried out at their Phoenix Works, Bradford.

The main line locomotives will have 1,700 h.p. diesel engines and hydraulic transmissions incorporating gearboxes and oil-operated torque converters. Forty five of these locomotives have been the subject of an earlier order.

The combined locomotive orders will carry a stage further the Western Region project for the replacement of steam by diesel power in the Bristol area, in the West of England (west of Newton Abbot) and in South Wales. Delivery of the 95 locomotives begins next year and will be complete by 1963.

Horwich railway workshops will build 63 of the shunting locomotives and Darlington 35. They will have 350 h.p. diesel engines and electric transmissions, the engine being coupled to an electric generator to provide power for the electric traction motor driving the axles.

British Railways now have a diesel shunting fleet of 1,600 locomotives. About 1,150 of them are the 350 h.p. type.

New Swedish Sports Car To be Made by Jensen

A sports car venture by VOLVO, the Swedish car firm, has been brought to Great Britain, where JENSEN MOTORS, a company of the NORCROSS GROUP, are to produce the new car, the Volvo P 1800 beginning in January.

PRESSED STEEL are to make the P 1800 body at their Linwood factory, in Scotland, and Jensen will assemble, paint and trim the new car. Three-quarters of the components will be British made. The car will take its engine, gearbox and rear axle from Sweden.

Among the components manufacturers who will have parts in the new car are JOSEPH SANKEY, wheels, HARDY-SPICER, propeller shafts, S.U. CARBURETTER, PIRELLI tyres, LUCAS, electrical equipment, GIRLING, brakes, SMITH (S.) AND SONS (ENGLAND), instruments, TRIPLEX, glass, and ICI, paints.

The 110 m.p.h. Volvo sports car will have two occasional seats for children behind the two full sized seats. Until the autumn of the first year all the cars produced will have left hand drive. Some three quarters of the output, it is planned, will be sold in the United States.

British Trade Fair Moscow, 1961

A useful side effect of the extensive British Trade Fair to be held in Moscow next year (19 May to 4 June) will be to put in the hands of Russian trade visitors a fair catalogue which is in effect a guide book to a large and go-ahead section of British industry.

More than 600 companies are taking part, and their products range from blast funnels for quick freezing poultry to shoe-making machinery and the ROOTES Group's multi-fuel engine capable of running on anything from diesel oil to cleaning fluids.

Basically, the fair will be held in four halls, two of which were built by the Americans for their show in the summer of 1959 and later sold to the local authority for half the building costs. The second two halls are being built by the Moscow City Soviet to accommodate the British show and then, a few days later, the French National Exhibition. Both Industrial and Trade Fairs Limited, the private company promoting the show, and the French organisation are to contribute £112,500 each to the cost of the new halls, the other half of the cost coming from the local Soviet's funds. JACK HOWE AND PARTNERS, the architects of the British fair, are working closely with the architects of the Institute Mosproekt who are carrying out the designs of the second pair of halls.

The exhibition's sections cover plant and machinery, electrical engineering, scientific instruments, materials (among them iron and steel, wood, plastics, rubber and glass), chemicals and pharmaceuticals, engineering components, transport (including passenger cars, commercial vehicles, rolling stock, locomotives and ships), medical, dental and veterinary equipment, textiles and clothing, leather and footwear, books, toys and games and musical instruments, household goods, office machinery and services (banks, airlines, Ministries).

Remote Control Of Machine Tools

" Somewhere in England," to make use of the old war-time phrase, electronics and hydraulics engineers are working on a project to operate a machine shop by remote control. Observing television screens in a central control room operators will eventually be able to conduct high precision machining work by turning knobs on a control panel.

The project is going ahead under a Government contract awarded to ARMSTRONG WHITWORTH EQUIPMENT, the Gloucester unit of SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT, a HAWKER SIDDELEY company.

The remote control unit will be built up using basically conventional tools. A similar scheme could be operated with standard workshop hydraulically-operated tools.

Armstrong Whitworth Equipment's electro-hydraulic servo valve, developed by the company as an industrial unit, is the basis on which the scheme is being worked out. Full details of the project are witheld for security reasons.

Cleaning a Silted Sewer by Plough

A sewer plough is being used in New Zealand to remove deposits from a 6½ mile sewer. The last cleaning was 20 years ago and present progress is slower than expected. Future passes should be quicker.

INSPECTION in 1957 showed that the 6½ miles of main sewer at Orakei, Auckland, New Zealand, had become heavily silted. Deposits ranging from 9 to 24 in above invert were found and estimates indicated that some 2,000 cu. yard of silt and metal were held by the sewer. As the system was to be retained as part of the new Manukau scheme, it had to be cleaned. The silt was seriously affecting the capacity of what was already an overloaded system. In addition, decrease in the flow through overflows was desirable to reduce harbour and creek pollution.

It was clear why the sewer had silted so much since it was last cleaned 20 years ago. There was insufficient flow velocity to scour it efficiently. With a gradient of only 1 in 3,000 for three quarters of the inspected length, the maximum velocity was 2·93 ft per sec. Accepted design practice aims at a minimum of 3 ft per sec to prevent silting.

It was not so clear, however, how best to clean the sewer. As it ran under high ridges, there were many long distances between manholes —up to 3,600 ft—and many of the manholes were deep: fifteen were over 20 ft deep, and one was 78 ft deep. In addition, entry could not be gained except through these manholes, whose shafts entered the sewer directly, without chamber or platforms. The sewer also received large quantities of storm water, the level inside rising rapidly and falling very slowly; and certain parts developed dangerous accumulations of poisonous gas from time to time. The structural condition, however, was quite good. (The sewer is egg-shaped in cross section; parts are constructed of reinforced concrete and the remainder has mass concrete to the springing with concrete blocks in the arch above.)

These problems which faced the Auckland Metropolitan Drainage Board are described by G. T. Searchfield in the June issue of *New Zealand Engineering*. They made it undesirable for men to be working in the sewer on a permanent basis, and a cleaning system was sought which would be unaffected by the season, weather, or normal daily variations in flow. It was also necessary for the cleaning to be fast enough to be completed before the completion of the Manukau scheme in 1960.

Winches and buckets, a scarifier, a water jet from a submersible electric pump floated down the sewer, and shovelling the silt by hand into punts, were all carefully considered but rejected. Under the circumstances, it was decided that sewer ploughs offered the best solution, although some troubles could be foreseen.

Sewer ploughs are vertical plates blocking the lower half of the sewer and pushed forward by the sewer flow. A framework with wheels enables the plough to move along the sewer in an upright position, while holes in the lower part of the plate provide a jet action that removes the silt immediately in front of the plough. As the plough progresses through the sewer a long mound of silt is carried before it. Removal of this by winch and buckets was considered feasible if the ploughs could collect the silt in suitable sections. Diagrams of the plough evolved for the Orakei sewer are shown below. For ease of handling through the narrow manholes, the main structure is of aluminium. Plugs regulate the jetting action of the holes.

A silt collection chamber already existed at the outfall end of the sewer, and a second was constructed about halfway along the complete length of the system.

After the first completed plough had been fitted into the sewer it travelled some 4,000 ft to the newly constructed silt chamber in about eight months, with the removal of 200 cu. yard of silt. There were many teething troubles to be overcome and much time was lost owing to wet weather. If the plough had to be stopped to pass a manhole or large junction, or if it became jammed, several weeks might be lost waiting for suitable weather to enter the sewer. The actual working time to travel this distance was estimated to be 10 to 12 weeks.

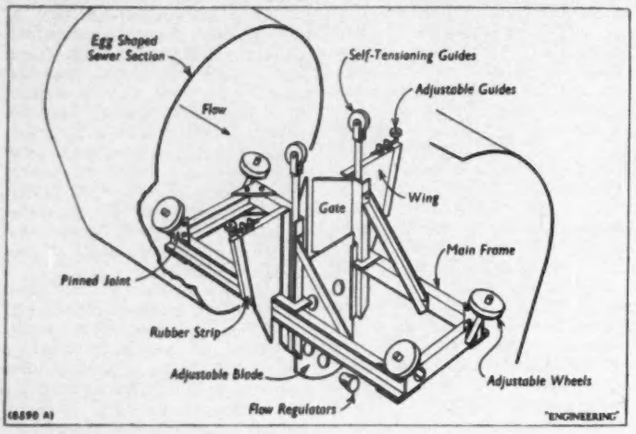


Fig. 1 (left) Diagrammatic view of the plough in a sewer. Plugs act as flow regulators to control the water jet action of the holes in the lower part of the blade.

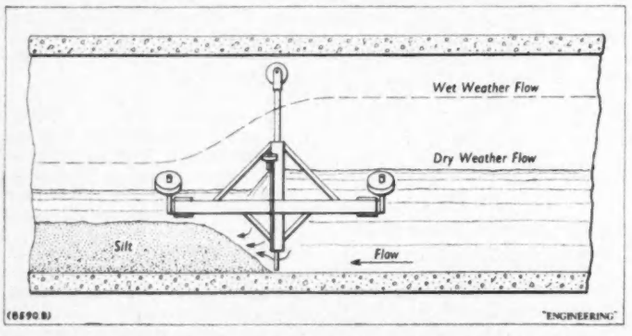


Fig. 2 (right) Longitudinal Section along the sewer in which the plough is working. The mound in front of the plough may extend for 600 ft and reach a height of 3 ft.

The trial being considered satisfactory, several similar ploughs were constructed to suit the various sizes of the sewer. Cross sections vary from 8 ft 6 in by 5 ft 8 in to 3 ft 6 in by 2 ft 4 in. This change in size is accomplished in nine steps. Construction of nine separate ploughs, however, was considered uneconomical; five were made, each to work in two sizes of sewer (two were identical, for work in a particularly long section). As the 3 ft 6 in by 2 ft 4 in section was not as heavily silted as the remainder of the sewer and was too small for successful plough operation, cleaning by plough started at the next largest size—5 ft by 3 ft 4 in.

As the various ploughs were built, wooden moulds of the sewer were made in which to assemble them. This facilitated final adjustments and served as a check that the plough could be assembled inside the sewer. A system of colours and arrows indicated the position of the components in the plough, and the gang assembling them had many rehearsals. Flow in the sewer has to be low when the ploughs are assembled, and for this reason, this work is usually carried out between 4 and 6 a.m.

When the flow is low during dry weather it has been found necessary to inspect the ploughs fairly frequently, as they become fouled with rags which block the holes in the blade. Mounds of grit and metal cemented to the sewer invert, and wedge shaped rocks have also caused the ploughs to jam. Several mounds of cemented grit have had to be cleared with crowbars, and in some sections quantities of rock up to 12 in in diameter have required removal.

Boards are wedged across the manhole shafts and step irons are removed from the path of the ploughs. For obstructions such as large branch junctions, the ploughs are stopped and eased past by hand. The ploughs are also stopped at changes of section by placing an expanding steel bar across the sewer.

When the ploughs are working, a mound of silt sometimes 600 ft long extends in front of them, moving along with the plough and reaching a maximum height of up to 3 ft directly in front of the blade. When this mound approaches the silt chamber, a line is attached to the plough which is then allowed to move forward in short steps, sufficient to fill the 20 cu. yd capacity of the chamber each time.,

Progress is very slow in dry weather, but very good with sufficient rain and no obstructions. The number of obstructions has been larger than was expected and has caused serious delays, especially in wet weather when the ploughs may be held up for several weeks before the flow is low enough for men to enter and free them. During wet weather the overflows on the sewer carry a larger flow than normal, owing to the presence of the ploughs, but there have been no complaints of surcharging on any of the branch lines.

It was originally thought that the ploughs could be placed in the sewer and forgotten. However, the large number of obstructions and the difficulties with rags made it advisable to inspect them every two or three weeks when possible. These inspections, together with the necessity to board the shafts and remove the step irons in the path of the ploughs, have meant that during the summer entry to the sewer has been necessary on the average about once a week. As the working conditions are often rather unpleasant, the men working in the sewer are recompensed by being paid over and above overtime rates.

To date, the ploughs have given a little more trouble than was expected. However, once each plough has passed through its particular section, subsequent passages to remove silt brought down by the upstream plough should be carried out with greater ease.

Dry Air Supply Aids Cleaning of Tanker Hold

Humidity and salt laden air are time wasters in shipyards. The work of reconditioning the interior surfaces of ships' hulls is seriously retarded by the action of such elements. A particular instance is the treatment of holds in tankers.

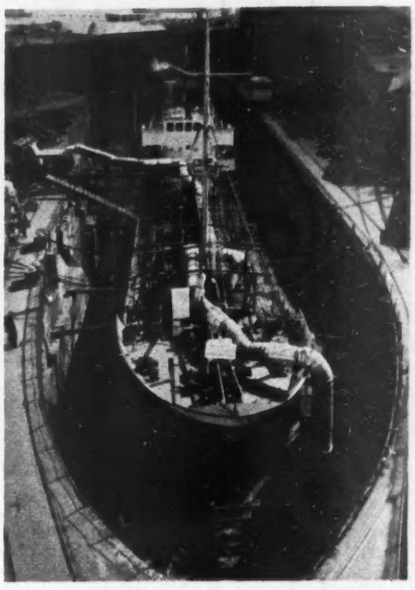
Periodically, it becomes necessary to descale the interiors of the tank compartments and treat the steelwork, to preserve the surfaces and prevent contamination of future cargoes. Speed is essential in this work. Within a very short time of scale and rust formations being chipped away, corrosion again appears on the structure, often before the surface can be treated with preservative. To prevent such a build-up of corrosion during work on the tanker Esso Hermod, Seaguard Limited, specialists in the field of hold preservation, used a Birlec dehumidifier to pump dry air into the hold continuously. This is claimed to be the first time this technique has been used in a British dockyard, in this case in dry dock at North Shields.

A model CR dehumidifier was installed on the dockside and ducting arranged between the unit and the ten tanks, situated five to port and five to starboard of the centre line bulkhead. Dry air was fed to these compartments at 1,500 cu. ft per min. Extractors were installed to work at the same rate.

For cleaning down the tank interiors, Seaguard used shot blasting. Shot was pressure fed from hoppers on the dockside to pneumatic guns operated by the rubber coated and helmeted workers in the ship's tanks. After descaling, the surfaces were washed, dusted and dried, and the waste shot removed preparatory to inspection, after which the surface treatment was applied. This was that known as "Humble Rust Ban," a product of the Humble Refining Company (owned by Standard Oil Company, New Jersey, USA). It takes the form of a one-coat zinc-silicate based preparation sprayed over with a curing agent, with a two-hour drying period between each application.

The dry atmosphere maintained the shot blast surface in a bright state during the subsequent routines, and the dry air supply was maintained until the final hardener had been applied. The dehumidifier used in this instance was capable of a dry air delivery of 3,000 cu. ft per min, and heating of the reactivation air was by steam. The equipment uses silica gel or activated alumina to remove water vapour from the atmosphere. When the gel becomes saturated with water it is regenerated by passing hot air through it. Once the water is driven off and the gel cooled it is ready for a further period of drying duty. By the provision of several beds of silica gel, some gel is available for drying while the remainder is being reactivated.

While the application of dry air in this way is not new to manufacturers of chemical, food and pharmaceutical products, electrical insulators, confectionery, etc., its successful application to a tanker opens up further fields for its use. It could be used in other industries where adverse weather conditions retard progress, for example, in large scale building projects.



Descaling treatment of the hold of the tanker was carried out in an atmosphere of dry air, instead of the usual moist air of shipyards.

Adjusting Diesel Exhausts to Reduce Air Pulsations

Successful reduction of noise and air pulsations from a diesel exhaust was achieved by modifications carried out during the early operational period of the type UE engines manufactured by Mitsubishi Shipbuilding and Engineering Company Limited, Nagasaki. The procedure used is described by the company's director of research, Hideo Fujita, in a paper "Service Records of Mitsubishi Nagasaki Diesel UE Type Engines and Improvements Made on the Engines," read before the Institute of Marine Engineers. The engine concerned is an exhaust gas supercharged two-stroke, versions of which are produced with outputs up to 18,000 b.h.p.

Exhaust air vibrations in the audio frequency range can be reduced by use of a silencer. But air pulsations below the lower frequency limit of audibility are more difficult to deal with. The nature of the pulsations was therefore investigated.

It was found that when the natural frequency of exhaust gas in the exhaust piping system resonated with the frequency of pressure pulsation of exhaust gas, a large air vibration was caused in the atmosphere near the funnel and an unpleasant pulsation was felt inside the wheelhouse and cabins. Further studies with a frequency analyser showed that the pressure wave whose frequency coincided with the engine r.p.m. multiplied by the number of cylinders had the maximum energy; other pressure waves were so small as to be negligible. Since the natural frequency of the exhaust system could be calculated it appeared possible to design the exhaust piping to be free from resonance vibrations in the operating range of the engine.

During the shop trials of the engine, experiments were carried out on the exhaust piping system. A similar system to that to be installed on the ship was prepared and temporary cabins were constructed. Tests were then carried out, the design of the exhaust being adjusted to reduce pulsations—the area and length of the exhaust passages were adjusted to keep the resonant point of the system away from the engine frequency, and suitable resistance and volume were added midway in the piping system. The drawing shows the arrangement of the exhaust piping before and after the modifications were carried out. The reduction in pressure variations obtained is shown in the graph.

Fig. 1 Exhaust gas passages of multi-cylinder marine diesel: (a) before modification, (b) final design that greatly reduced pressure pulsations.

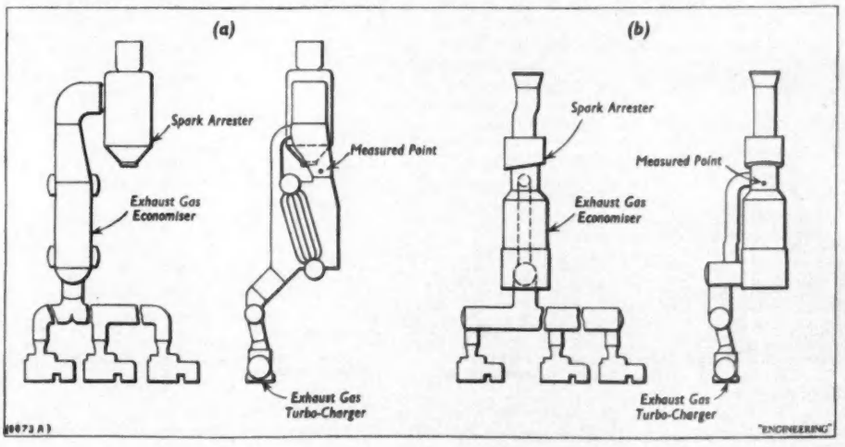
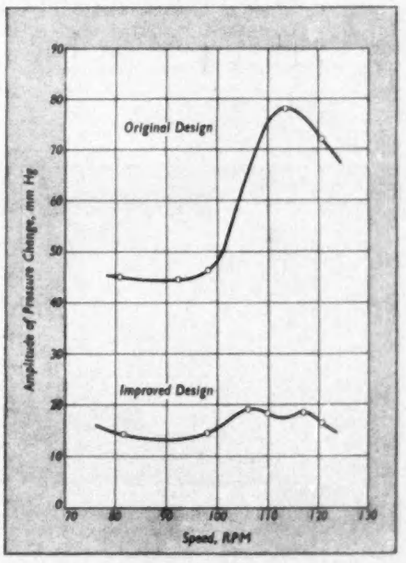


Fig. 2 Pressure changes in the exhaust pipe before and after modification.



Making Service Equipment More Reliable

Product reliability is a function of the reliability of a product's constituent components. This means that quality engineers are needed by sub-contractors as well as main contractors.

By Frank Nixon, B.Sc. (Eng), M.I.Mech.E., F.R.Ae.S., M.I.Prod.E.
Chief Quality Engineer, Rolls-Royce Limited

SERVICE equipment differs from civil equipment mainly in the much higher duties that are imposed upon it. This not only increases the difficulty of achieving the desired degree of reliability but introduces a tendency to look upon the reliability of service equipment as a problem requiring a unique approach.

All equipment, however, both civil and military, is manufactured. Therefore, no matter how advanced a design or a manufacturing technique may appear to be, in the last resort it is dependent upon human effort. Moreover, and to a far greater extent than is usually realised, the most complex and sophisticated assemblies are still dependent upon the efforts and the products of what might be considered small backward firms.

The overall reliability of equipment can be no greater than the aggregate reliability of the constituent components, and it behoves us, therefore, to ensure that the performance of the manufacturing side of British industry as a whole is as good as that of the leading firms.

Experience shows that at the present time this is very far from being the case. Most small firms, too, are of the opinion that any improvement in performance is beyond their reach, and is only for the giants.

Silvanus P. Thompson said 50 years ago,[1] " What one fool can do, another can," and there is no reason why every firm in industry cannot follow this example, to its own immediate good and to the ultimate benefit of the nation.

The cornerstones of the Rolls-Royce organisation, which resulted in its name becoming a household word synonymous with quality within only four or five years of the founding of the firm, were:

1 The realisation of the importance of a balanced and completely integrated organisation, in which design, development, manufacturing, proving and after sales service all play their part.
2 The insistence that nothing but the best is good enough, coupled with the realisation that the best can often be achieved at no cost other than the effort of the individual who, under inspired leadership, will, in the words of Lord Hives, " work 'til it hurts."
3 A self-generated competitive spirit, leading to a continual effort to better one's performance.
4 An insistence upon prolonged overload and endurance testing. At the time of its inception —the early 1900's—this was quite remarkable. This has always been coupled with insistence upon immediate attention to all defects and difficulties, as revealed by the testing and by customer experience in the field.[2]

The company, in common with most large organisations today, is dependent to a considerable extent upon a large number of small firms. If the work and the products of these firms cannot be depended upon, the quality and the reliability of the final product will suffer.

QUALITY AND RELIABILITY

Both quality and reliability are abstract conceptions, and a great deal of confusion exists regarding the nature and functions of both of them.

Reliability has been described as the probability that a device will continue to function, satisfactorily, for as long as it is expected to do so.

Quality Engineering has been described as the maintenance of a degree of consistency of product which will be acceptable to the customer.[3]

The user, and especially the user in the Service sense, needs to know what is the probability of failure of his equipment, so that he can plan accordingly. The producer must always, for the reason that he can never be fully cognisant of all the factors involved, endeavour to achieve the maximum consistency of his product, at the level which will have been established by prototype trials, or by a specification.

Reliability requires that the equipment shall have been designed with full consideration for every foreseeable contingency that might bring about breakdown in service. A quality product may be unreliable, due to some deficiency in its design, but without the fullest exercise of quality engineering, no product, however well designed, will be reliable.

Much Service equipment is designed or specified by Service Departments, and manufactured on a contractual basis by industrial firms (" vendors " or " sub-contractors "), many of whom are unaware of the detailed Service requirements, except insofar as these are defined by the specification. Reliability depends upon the continued efforts of the writer of the specification, the designer, the manufacturer and the user. These require to have an understanding of and a regard for each other's problems and difficulties which is unfortunately all too rare.

For a proper appreciation of the situation it is important to realise how, with few individual exceptions, British industry differs from that in America, Russia and many European countries. The shortage of engineers and scientists has received much publicity, but what is not realised is the considerable disparity between the numbers of engineers employed in the manufacturing side of British industry, as compared with those in the research, design and development departments. In these other countries an enviable state of balance exists between the different sections of their organisations, and there is a good deal of lateral movement of personnel from design to manufacturing to development, and so on. It is usual to find in American companies a far greater degree of understanding of and sympathy with the problems of other divisions of an organisation than here. It is quite common to find, in factories both in the United States and in Russia, foremen who are graduate engineers.[4]

Our own industrialists are not without responsibility for this situation. Until quite recently the graduate engineer has been unwelcome in the workshops of all but the enlightened few firms, and has been directed instead to design, research and development.

When reading of the efforts which have been made to improve reliability in other countries it must be realised therefore that there already exists a manufacturing division which possesses a far bigger and stronger technical staff than is usually found here. Apart from the obvious advantages, this means that the more technical aspects of reliability and of quality control are much more readily appreciated, understood and adopted.

In peacetime few industrial firms in Britain are occupied solely with military equipment. The more usual case is the firm specialising in some corner of industry, and which by reason of its special experience has become interested in the manufacture of some piece of Service equipment as a minor fraction of its total activities.

It is far more likely than not that the typical firm, although its main business is in a competitive commercial field, has not yet adopted quality engineering or quality control to any effective degree. Since reliability is dependent upon quality, this is a vital omission.

Where a firm is responsible for the primary basic design of its product, then—since presumably the firm has already gained a foothold in military business—its designers will be conscious of the difficulties facing them. It is doubtful, however, if many of them will have available adequate knowledge of the behaviour of their product in service.

It is extremely unlikely that more than a small minority of them will have any idea at all of the variability of the properties of the materials and components upon which they must depend.

Abridged version by the author of his paper to the Interservices Symposium on the Reliability of Service Equipment, London, March, 1960.

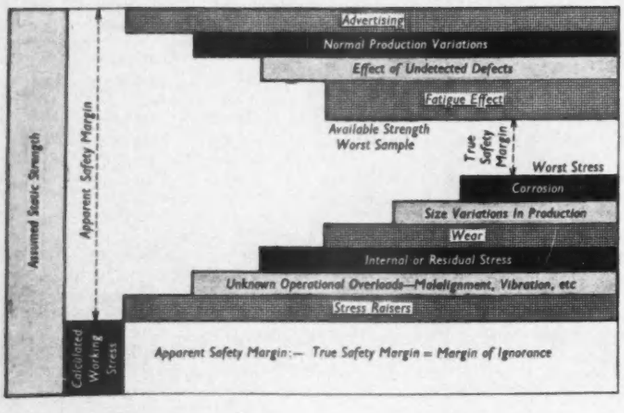


Fig. 1 (left) The basis of quality engineering. The true safety margin is equal to the margin of ignorance.

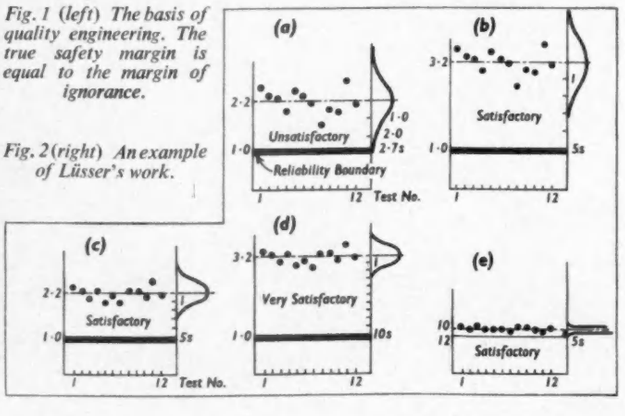


Fig. 2 (right) An example of Lüsser's work.

These are the reasons why the most important initial step which needs to be taken by the great majority of British firms is to increase the technical strength of the manufacturing side. Quality engineering offers the most convenient and effective means of doing this.

It provides an essential rung in the ladder from design through development and manufacture to reliability. Unlike some of the actions which are necessary to increase overall reliability, quality engineering will be found to provide, in addition, an appreciable financial saving, as much on the commercial as on the military side. There is no reason, therefore, why it should not be introduced into every firm, however small.

QUALITY ENGINEERING

The principles and functions of quality control have been dealt with elsewhere.[5]

The basis of the quality engineering part of the overall function of quality control[3] is the diagram in Fig. 1. This shows how by taking action to diminish the margin of ignorance, it is possible to work reliably with a low margin of safety, and the aim of the quality engineer is to study and to bring under control all the factors shown.

Precisely the same thinking has been described contemporaneously by Lüsser,[6] from whose work Fig. 2 is taken.

Consideration of these diagrams leads to a clear understanding of the three-fold task of the quality engineer:

1 To assess the variability which is permissible, i.e. to determine the lowest standard of acceptance.
2 To assess the variations which are likely to occur throughout the production run, i.e. to determine the quality of the worst sample produced.
3 To take the minimum steps necessary to ensure that the worst sample produced is no worse than the minimum standard required.

Turning now to the small firm which is supplying many of us with functioning units, we have seen already that military business is seldom its main concern. The specification will often have been drawn up as a first assessment of the requirements of the equipment. Such is the frailty of man, however, that its author, who is probably quite unknown to the manufacturer, will come to look upon it as the last word on the subject, while the contractor will look upon it as a legal document which specifies the optimum level of performance required. The contracting firm will be remote from the end use of the product, and so will not have a full appreciation of its duty, nor of its deficiencies in service. In the common case where the product is embodied in a much larger assembly—a rocket or an aircraft say—the sub-contractor can always blame the main contractor for any failure.

Finally, the state of affairs in this country is unfortunately such that there is little competition in the fields with which we are concerned. Many of the firms, even the small ones, are specialists, enjoying a monopoly or a near monopoly.

There can be no quarrel with the attitude of mind of the executive who sets out to meet the bare minimum requirements of the specification. After all, he has a balance sheet to maintain, and he would probably meet with severe criticism if he committed his company to any "unnecessary expenditure."

Yet in very many cases within the author's personal experience a sub-contracted unit has succeeded in meeting the specification, but has suffered from gross unreliability in service. The remedy has often been simple and cheap.

All that has been necessary has been to test a small number of units to failure, to diagnose the cause of failure, to take remedial action, and to substitute for the official acceptance test a simpler one designed to "press where it hurts." The table shows some of the increases in reliability which have been gained in this way. Cases are known where a prototype unit has successfully completed the specified number of operating cycles but has not been dismantled to see what state it was in. This was acceptable to the inspection authority—the unit had passed its Type Test! Almost invariably, troubles experienced subsequently in Service were found to have been present in the type tested unit, at least to the discerning eye of the main contractor's quality engineer. But the sub-contractor was being paid only to pass the type test in order to qualify for a production order, and he had done this. He was not being paid to develop reliability into his product.

The need here is obvious—there must be more development testing, a greater readiness to modify specifications in the light of experience, and a much better system for the collection and dissemination of information regarding troubles in service, with, at the very least, proper information on established conditions of service.

All these require action by Government departments—the first, to allow more money for the initial stages of development; the second requires a new attitude of mind. Specifications should not be finalised until there has been sufficient testing to provide the necessary experience. Regarding the third, it is realised that systems of reporting exist, but these often fail because the interest of the engineering personnel in the field is not maintained.

The considerable improvements in reliability which have been obtained in the cases quoted illustrate at once the value and the relative ease of adopting quality engineering. In every instance no high degree of technical talent was required, but rather an independent, questioning approach. Just as the great majority of people are fundamentally honest, so also everyone tries to do a good job. The designer, the development engineer, the production man, and the inspector, will all have exerted themselves to avoid all possible pitfalls. When trouble arises the cause of which is difficult to diagnose, it is usually found to be due to some simple, silly mistake or oversight, rather than to a highly technical error. But those most closely connected with it can often only see trees. An outsider does not need to be clever to be able to see the wood as well.

The man who becomes conditioned to the quality engineering outlook is usually quick to spot the likely weaknesses of an assembly. In this, experience obviously plays a large part, and since in some fields of endeavour quantities are too small to provide samples of statistically significant size, engineering judgment must play a correspondingly greater part. In the words of Juran,[7] there should be concentration on the "vital few" troubles which cause the major unreliability. By the time these have been eliminated, the reliability of most equipment will have reached a satisfactory level.

It is more important that these points should be appreciated by those responsible for government specifications and product performance. There was a case recently in the United States when a Service department let it be known that it was prepared to pay three times the prevailing price if the required reliability were forthcoming. A statistical investigation showed that the desired quality could be achieved, and the cost halved, by attention to the vital details.

CONCLUSION

Before there can be any real advance towards a worth-while increase in the reliability of service equipment, it is essential that every firm which is making a contribution to that equipment shall take all the steps necessary to ensure the quality of its product. This includes all firms, from those supplying raw materials, to those making bolts and split pins. In this connection, material suppliers are most earnestly exhorted to provide data, not only of the optimum properties of their materials, but also of the scatter bands, based on samples of significant size.

The introduction of quality engineering, at the outset, involves no more than the delegation of one or more individuals, depending upon the value and the complexity of the product, to cultivate the attitude of mind and approach which have been indicated. As has been shown, it is highly probable that this venture will prove to be extremely profitable. Inaction can have only one result—retrogression. Action along the lines described, even though at first it may be hesitant and groping, cannot help but be of value.

As far as overall reliability is concerned, the best advice is probably that given by Leonardo da Vinci:—

"When you wish to produce a result by means of an instrument do not allow yourself to complicate it by introducing many subsidiary parts, but follow the briefest way possible."

Or, in the immortal words of Bill Stout in the 1930's:—

"What you don't put into an airplane don't give no trouble—simplicate, and add more lightness."

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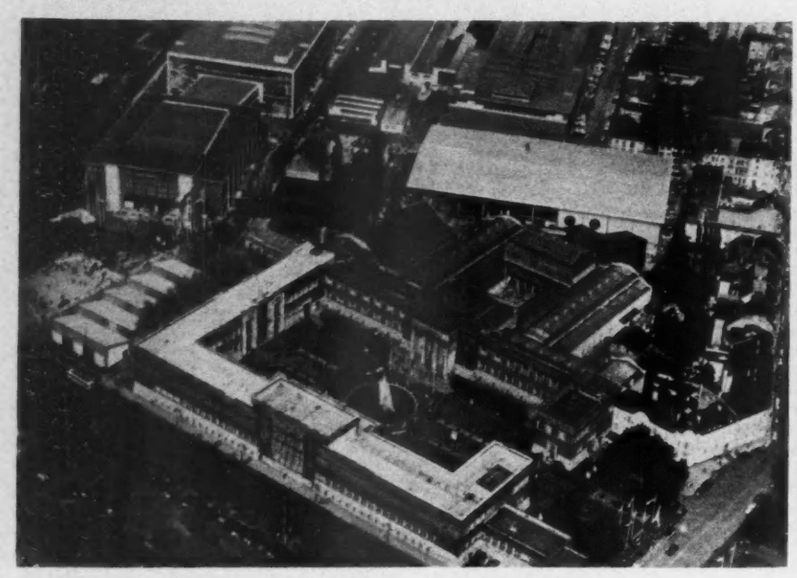
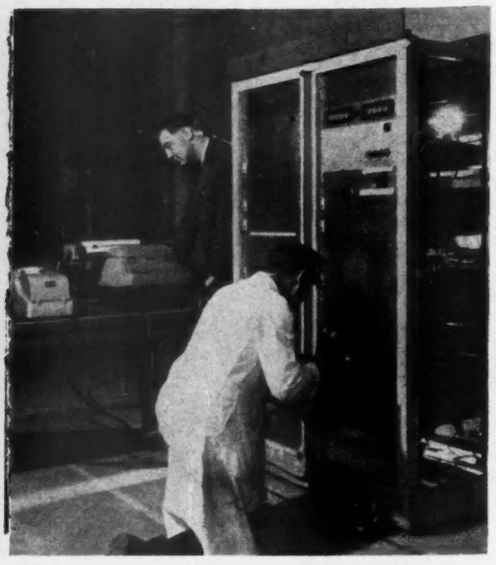
TABLE:—*Examples of Improvements in Reliability Following Quality Action*

Item	Trouble	Life on Rig Test Initially	Diagnosis	Action	Life on Rig Test of Corrected Component
Condenser for high energy ignitor	Early failures in service	250 cycles of operation	Kinked and broken foil and insulation	Improved winding technique with controlled tension, improved dielectric paper	3,500 cycles
Limit switch for fuel datum control	Early failures in engines in service	Contact pressure fell to 20 grams after 450 cycles of operation	Low contact pressure due to variations in spring load, and malalignment	(*a*) Improved jigging and assembly (*b*) Control of spring pressure (*c*) X-ray check for alignment	Contact pressure maintained at 26 grams after 10,000 cycles
Aircraft engine oil tank welded steel construction	Early failures in service due to cracking at welded joint	1,190 cycles of hydraulic pressure testing caused failure	Poor fit of mating parts and inadequate weld penetration	Improved fit, and check of weld penetration	189,000 cycles
Aircraft engine oil cooler. Soft soldered copper and brass	Early and widespread failures in service	< 100 cycles of hot pressure testing caused failure	Poor soldering techniques and poor fit of mating parts	(*a*) Training of operators (*b*) Improved storage of pre-tinned parts (*c*) Improved soldering techniques (*d*) Improved fit of mating parts	500,000 cycles



The site of Interkama. The exhibition covered over 400,000 sq. ft of floor space.



Tests on equipment made by Honeywell Controls.

How Data Processing Helps Production

The growing size and complexity of modern production plants has been accompanied by an increasing need for data processing equipment.

ONE of the features of the post war years has been the development of data processing. Large production and processing plants today require a vast number of control points, whose data must not only be easily assimilated and surveyed but must also be further processed to permit computing operations or to initiate automatic control processes.

Conventional evaluation of such data would, in large plants, require a labour force which can no longer be justified economically. Therefore, as automation advances, greater use is being made of automatic devices connected directly with the various measuring units and which effect the necessary evaluation quickly, reliably, and accurately. The larger the production volume, the less satisfactory it becomes merely to read the required data from indicating instruments, to record them by means of recording devices, or to feed them into control systems. In some industries, for example, it is essential to have quantitative statistics covering output, raw material consumption and power consumption—such statistics can only be obtained from a multitude of different data. For such fields of application, only briefly outlined here, a " new " type of measurement has proved itself useful.

CONVERSION PROCESSES

In measuring, we make a basic distinction between two different types, analogous and digital measuring. Thus, the pointer of an electric indicator constantly plays over a scale, just as the pen of a recording instrument constantly moves across the recording surface. In this type of measuring the representation of the value measured proceeds analogously with the change of physical quantity to be measured.

In digital measuring, on the other hand, the measured quantity is represented by a simple number. The term is derived from the word " digit " which has its origin in the Latin *digitus* meaning a finger. In ancient Rome, area and distance were at first expressed only by a number of digits: no fractions were given.

Although we are today more familiar with analogous measuring, digital measuring methods are nevertheless very old. Quantitative measurement of drinking water, as practised in Ancient Egypt and in the oases of the African deserts even today, is to all intents and purposes a digital process, since the quantity of water supplied is measured not by its continuous flow, but counted by the " quanta " of buckets produced. Thus, the quantisation of a measured quantity, its splitting up into part-quantities, represents the basic difference from the analogous method.

However, in order to be able to carry out such a digital measurement, special conversion processes are needed, i.e., the measured quantity presented analogously must first be coded digitally before further processing is possible. The precision of an analogue to digital conversion can be very high indeed.

Depending on the task in hand, conversion can be effected by instantaneous value or constant value converters. In order to convert the measured quantity into its digital form, it is quantised in these instruments, i.e. the number is formed from the smallest distinguishable units contained in the measured quantity. This number is then presented by the converter in a certain code.

Production digital systems are mostly based on binary or binary-decadic conversion, since the conventional, decimal based system can only be handled electrically at great expense.

Dual code elements only have two stepped values, such as on/off or zero/full value, and can therefore be processed as pure yes/no decisions by the usual electrical and electronic components such as relays, transistors, valves, etc. Any given number will thus be presented as the sum powers of 2. The number of yes/no decisions—generally called bits (binary digits)—will, for example, with binary conversion up to the number 999, corresponding to a precision of 0·1 per cent, be much smaller than with the decimal system. In this case, 10 bits are sufficient with binary, and 12 bits with binary-decadic conversion. Naturally, this numerical representation which in no way corresponds to our way of thinking cannot be used for numerical indication, so that in data processing the code must in the end be reconverted into the conventional decadic form.

Meanwhile, data processing has reached a technical level which already permits a clear sub-division of tasks. Fairly extensively standardised systems exist today which are ready for use during the planning of production plants, and are already used with success in a number of branches of industry. Data processing equipment was a feature of the recent Interkama 1960, the International Congress and Exhibition for instrumentation and automation in Dusseldorf.

Every data processing instrument is composed of several units whose combination is chosen according to the type of task to be solved. In a system for production control, all important measured quantities are governed by an automatic switch and collected cyclically. A teleprinter is used as the output unit. It is capable of printing about 25 3-digit measured quantities per line, in addition to a 4-digit time indication. This instrument also incorporates computing and numerical comparison circuits by which, for example, the measured quantities can be checked for their position within admissible tolerances. If limiting values are exceeded a magnetic colour switch is actuated in the teleprinter, so that the values lying outside the prescribed tolerances appear in red on the printed record. Also, a card-puncher and tape puncher can be connected in parallel with the teleprinter to store the measured values on a punched card or on tape for further evaluation or fed into other printers or other punched card operated instruments.

ADMISSABLE LIMITS

Systems for processing raw material and power consumption data serve mainly economic purposes. Here, data processing has the task of presenting raw material and power consumption in the form required for statistical purposes. These data are not needed at the time of measurement, and the machine counts and stores them in a suitable form. A further evaluation can then take place in punched card machines or on punched tape.

In large production plants in the chemical industry, or in nuclear reactors, where a particularly large number of measuring points has to be controlled, a device can be used for the rapid control of limiting values. It selects certain measuring points in turn and examines them to see whether the meaured values lie inside the admissible limits.

For the control of a process the determination of a single numerical value is often sufficient to indicate whether or not a process is operating satisfactorily. This involves the task of constantly carrying out calculations, in which measured values are combined into " guide numbers." These always-identical calculations are carried out by a digital computer.

Wrecking Crane for Arctic Conditions

Designed for restoring 120 ton ore-wagons to the track, the crane is constructed to withstand conditions of extreme cold in Quebec province.

ARCTIC operating conditions had to be borne very much in mind in the design of a diesel wrecking-crane for a Canadian mining company. The Quebec Cartier Mining Company mines iron-ore near Lac Jeannine in northern Quebec province and temperatures at the mines often fall to − 60° F.

In the spring, when the snows melt, the ore-laden trains of 120 ton wagons are frequently derailed, blocking the only outlet to the port of shipment. Large cranes are needed to right the defaulting trucks and the mining company decided to order one crane of 250 short-tons capacity and another of 150 short-tons. In the face of stiff American competition, Cowans, Sheldon and Company Limited, of Carlisle, won the contract. This article deals with the larger of the two, which has just been completed.

500,000 LB LIFT

The maximum axle loading when in running order with the jib suspended and blocks supported upon a match truck is 68,000 lb, while the maximum lifting capacity with outriggers set is 500,000 lb — 250 short-tons — at 17 ft 6 in radius on the main hook. Length over the couplers is 40 ft, and the axles are at 5 ft centres.

Power is supplied by a Rolls-Royce 6-cylinder liquid-cooled supercharged diesel engine, C6SFL model, rated at 255 b.h.p. at 1,800 r.p.m. Fitted with a Twin-Disc torque converter, the engine is suitable for operating in ambient temperatures down to − 60° F, and is arranged to start with an engine temperature of − 10° F. Cooling for the radiator—which is independently mounted —is by a hydraulically driven fan. The air intake louvres are operated by a thermostatically-controlled hydraulic mechanism. An immersion heater is fitted in the coolant system for operation from mains while the crane is in the depot. Insulation and an immersion heater are also applied to the 125 gallon fuel tank. A transfer pump is fitted to facilitate refuelling in the field.

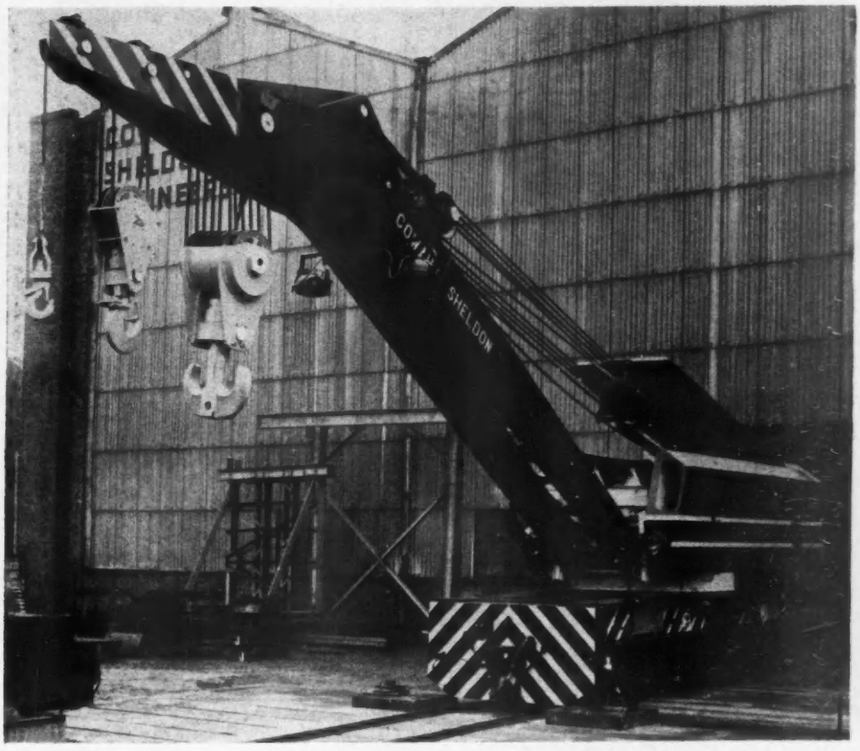
Auxiliary power is from a 2 cylinder Lister air-cooled diesel engine of 8½ b.h.p. and it is close-coupled to a 4 kW, 115 V generator to provide power for the lighting.

The torque converter takes its drive through an epicyclic reverse gearbox with enclosed spiral-bevel gears and longitudinal cardan shafts to the crane machinery. Drive to the slewing-rack is transmitted through reversible friction clutches and bevel and spur gears, a slewing brake being provided. Drive to the wheels from the superstructure is taken through the centre-pin to spur gears with sleeves on the main bolts which hold the centre jacking-beam reaction plate. Then bevel and spur gears take the drive to the inner axles of each bogie. Here the spur gear is barrelled to allow for pivoting of the bogie. Sliding pinions enable the drive to be disconnected when the crane is being hauled. Parking brakes on the wheels are operated from the trackside. When running in train, Westinghouse air brakes provide automatic braking.

DE-ICING EQUIPMENT

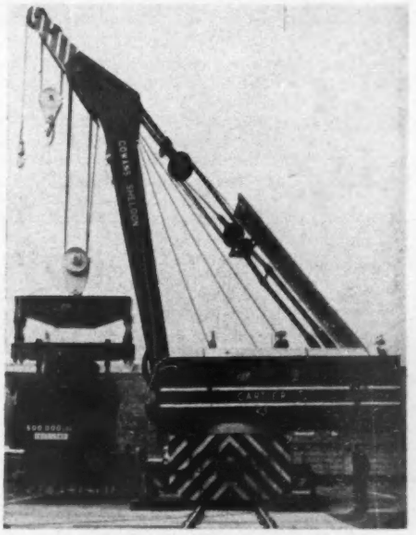
The superstructure rotates on a large diameter roller thrust-bearing consisting of a live ring of conical rollers rotating between upper and lower pathways. A centre pin is secured in the carriage to keep the superstructure in correct alignment and to carry the vertical forces.

All the machinery, the engine and the counterweight are carried in the superstructure which is of welded steel-plate construction. Enclosing the superstructure is a sheet-metal cab insulated with a 2 in layer of Rocksil lining. Roof sections over the main machinery are hinged and lift with the derrick tie-rods. Windows are of toughened glass and generally double-glazed. De-icing equipment is fitted to the driver's window. A Smith oil-fired heater is installed primarily for engine warming in severe weather, but outlets enable hot air to be bled off to external de-frosting equipment.



(Above) Because of the low temperatures at which the crane is designed to work, the jib is constructed of Coltuf steel.

(Right) The full load of 250 short-tons can be slewed through 360° in two minutes.



On account of its exposed position and to obviate brittle fracture at low temperatures, the jib is constructed of Coltuf steel. It is a welded fabrication having a box section and built on a swan-neck pattern. The main lifting block is carried on 12 falls, the auxiliary on four and the whip hook on a single fall of steel wire rope. The main hook is of the ramshorn type while the other two are of trapezoidal section. All three hooks are carried on roller or ball thrust-bearings. Ropes are coiled on cast steel barrels and gearing is used in conjunction with the torque-convertor to give increased speeds automatically with light loads. The crane will lift the maximum load at 5½ ft per min, 112,000 lb at 30 ft per min on the auxiliary hoist, and 28,000 lb at 130 ft per min on the whip. Lighter loads may be lifted on each hoist at speeds up to twice the full-load speed with half the full-load being lifted. Speeds are automatically increased.

Slewing through 360° with the full load is completed in 2 min and the jib may be derricked-in from the normal running height to the minimum radius in the same time. A straight travel with an 86,000 lb load is possible at a speed of 150 ft per min on a 2½ per cent gradient, or at 300 ft per min on the level. On the jib, a radius indicator and cant indicator are fitted. The main hoist is fitted with an electronic weighing scale operating on the ropes.

High tensile steel is used for the carriage frame which again is of welded construction. Telescopic draw-beams (or outriggers) fitted with screw-jacks at their outer ends, are provided in housings at the centre and ends of the frame. These draw-beams and jacks can be operated either manually or with a power winch.

The two six-wheel bogies are of one-piece cast-steel construction. Axle loads are equalised and when the crane is working, the springs are relieved of excess loading by jacking screws embodied within each spring group.

The makers claim that this wrecking crane—which was designed, built and tested within nine months—is the largest of its kind ever built outside the United States.

Designing a Drawdown Forging Press

By J. G. Frith, M.I.Mech.E.

Assistant Chief Engineer, Davy and United Engineering Company Limited

Pushdown forging presses have been used for many years but the drawdown type has advantages to offer. Operating gear is below floor level, reducing fire hazards and giving better access for forging, handling and tool changing.

For many years the basic design of the open-die type of hydraulic forging press used for general work has remained virtually unchanged, and has consisted of a four column unit in which the upper member is pushed down by hydraulic cylinders and rams mounted above it in a fixed top member. An alternative type of press, in which the cylinders and rams are located below the bottom fixed member, and operate on a bottom moving-crosshead which draws down a top moving-head by means of the columns, was suggested towards the end of the 19th century, but never came into general use for forging work largely owing to the much deeper foundations required. The greater ratio of moving weight to fixed and the location of the cylinder and pipes below ground, were also considered a disadvantage.

Recently, however, the increasing tendency to use small high-speed pumps operating on oil as the power source instead of the steam-hydraulic systems of the earlier presses, or the larger and slower-running water pumps with or without hydraulic accumulators of later presses, has revived interest in the "draw-down" press, and after careful consideration Walter Somers Limited decided to adopt this design for a new 3,000 ton unit to replace an old press of the same power in their works at Halesowen.

WHY A DRAWDOWN TYPE

The various reasons which led to this decision were:—

1 The head-room required as compared with that for a conventional press is much less (see Fig. 1).
2 The draw-down arrangement enables two columns only to be used in place of the four required on the conventional top-cylinder design. This gives greater working space around the press, and the diagonal arrangement of the two columns greatly improves the operator's view of the working faces.
3 The absence of cylinders in the top crosshead reduces the width of this item and allows closer crane approach.
4 Although deeper foundations are necessary, these can be extended to provide accommodation for the pumps, motors and valve gear in a situation below ground where they can be kept clean and free from damage, and where air conditioning can be applied if required.
5 All hydraulic units and pipe connections, except those for the low-pressure top-tool gripping units, are below floor level where any accidental leakage is far less dangerous than it would be above ground. The pipe connections are then as short as possible.
6 As the cylinders are mounted in the fixed member the high pressure piping is not affected by side sway during eccentric forging, thus eliminating a major cause of leaking joints.
7 The entire working area around the press is clear of pipes or other obstructions.

These advantages, it was felt, far out-weighed the additional cost of the more elaborate foundations and the greater proportion of moving weight as compared with the top-cylinder type of press.

As finally adopted, the press design incorporates other features (see Fig. 2) such as the provision of a tool changing gear, set at an angle of 25° to the transverse centre line of the press and extending into a tool storage bay, and an anvil sliding gear arranged parallel to the longitudinal axis of the building.

With a top-cylinder press the use of two columns only would give a lack of stability due to the fixing point of the columns being in the base, and hence at the maximum possible distance from the press head where side-sway occurs. With a draw-down press, however, two columns are allowable as the moving portion forms a frame having its centre of gravity within the fixed member in which it slides, that is, at about the mid-point of the column length. Any horizontal movement of the press head must therefore be less than that of the more conventional push-down press, and is still further reduced by contact between the top tool, mounted on the under side of the head, and the forging. The only restraint on the top head of the push-down press is that provided by the stiffness of the columns.

RECTANGULAR COLUMNS

The columns themselves, as the most highly stressed members of the press structure, formed the subject of a special design study; the material chosen being a forged alloy steel having an ultimate tensile strength of 40 tons per sq. in. with a yield point of 22 tons per sq. in. A factor of safety of 2·5 to 1 was selected against the possibility of column failure due to the combined effects of pulsating direct tension and reversed bending under the most severe conditions, which occur when forging at the maximum allowable eccentricity of 18 in measured from the dead centre of the press along the centre line of the tool. On this basis a column diameter of 32 in was initially chosen as being suitable from a stress point of view, but further calculations showed that the deflection at the top of the press when forging under full power and at the maximum allowable eccentricity would be 0·4 in.

Consideration was therefore given to the use of columns of rectangular section, 32 × 26 in with rounded corners, which would have approximately the same weight as the 32 in circular columns, and it was found that with these the deflection would be reduced to 0·3 in if fitted with the longer sides normal to the line joining the column centres. There would be a slight increase of stress as compared with the columns of circular section, as shown on Fig. 3, but this stress would still be within the maximum figure adopted as a starting point, and as the rectangular section columns would increase the stiffness of the structure against lateral loads such as those applied by an ingot turning gear, and the flat sides would facilitate adjustment of the guide bushes in the fixed crosshead to take up wear, they were finally decided upon. Special care was taken over the blending of the flat faces and the rounded corners into the larger circular shoulders on the columns which abut on to the top and bottom moving members of the press frame, and a taper of 15° with ample radii and a smooth finish was adopted.

The fixing of the ends of the columns into the top and bottom crossheads is by prestressing between the shoulders and the column nuts, supplemented by a tapered locking bush wedged tightly between the circumference of the shouldered portion and a tapered recess in the appropriate crosshead. Early presses had flat-faced shoulders fitting on flat facings on the press head and base, but it was often found that the effectiveness of the prestressing diminished or disappeared altogether with time, and that considerable movement and wear then took place between the mating surfaces, leading to excessive

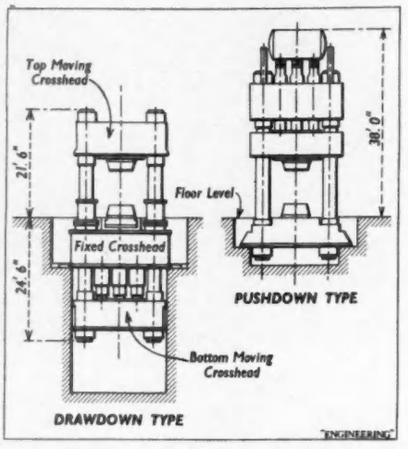


Fig. 1 Comparison of 3,000 ton forging presses of drawdown and pushdown design.

press sway. Conical seatings were adopted later to overcome this and were quite successful, but it is difficult and expensive to ensure that the conical seatings bed in such a way as to give exactly the same length on all columns between the top and bottom members when the columns are comparatively long. The flat-faced design with the tapered locking bush gives virtually the same effect as the conical seatings, with much more easily attained accuracy.

The bottom moving crosshead of the press which forms the lower member of the moving frame, is designed primarily as a beam to carry the loads from the main cylinders, which are three in number so that the press can work at one-third, two-thirds, or full power. The principal forces acting on the beam are thus the three downward loads due to the cylinders and the two upwards loads due to the columns through which the press power is transmitted to the top tool. In addition there are two further loads due to two balancing cylinders which take part of the weight of the moving frame and give a measure of control during lowering. These balancing cylinders are supplied with hydraulic fluid from a gas loaded accumulator and are under pressure at all times. Two further cylinders, of the same power as the balancing cylinders, serve to lift the moving frame but these are valve controlled and their power is not applied at the same time as that of the three main cylinders. A beam designed to withstand the effects of the main and balancing cylinders together can thus easily cope with the effects of the lifting and balancing cylinders, which are arranged with one lifting cylinder and one balancing cylinder disposed adjacent to each press column.

MOVING CROSSHEADS

The bottom moving crosshead is a steel casting having an ultimate tensile strength of 32 tons per sq. in with a yield point of 16 tons per sq. in, and the calculated stresses under full press power, when forging at the maximum allowable eccentricity do not exceed 4·5 tons per sq. in for direct tension, 3 tons per sq. in for shear, and 5 tons per sq. in where tension and shear occur together.

The top moving-crosshead (Fig. 4) also a steel casting having the same properties as the bottom member, carries the two downward loads due to the columns, and the equal and opposite upward load due to the top tool. This latter

load can be considered as being distributed over the tool flange but again allowance must be made for eccentric forging which can increase the load on the column nearest the eccentricity to 1,700 tons.

The bending stress at the centre line of the press under these conditions is 4·5 tons per sq. in, but an additional factor occurs due to the shape of the top member where the centre portion is arranged normal to the longitudinal centre line of the anvil sliding gear to provide a suitable mounting for the top tool and where the two ends are cranked to engage the columns. The twisting moment due to this arrangement, when applied to the particular section chosen, gives a stress of 1·8 tons per sq. in which combined with the stress due to bending gives a maximum principal stress of just over 5 tons per sq. in. The actual section is of box form, suitably ribbed, as this makes a convenient housing for the clamping devices which secure the top tool and the top tool holder. These devices consist of spring clamps, released when required by means of hydraulic cylinders, thus doing away with the bolts and cotters used for this purpose in the past.

FIXED CROSSHEAD

At first sight, the fixed crosshead might appear to be in simple compression only due to the press load, applied through the bottom tool, on its upper surface and to the upward reactions of the main cylinders on the underside. The only forces causing bending would then be the weight of the forging and of the crosshead itself together with the reactions of the balancing cylinders, all acting downwards on the crosshead which forms a beam spanning the pit in which the lower portion of the press is located. This is the condition when forging in the normal manner, but the press is also intended to perform becking —or hollow forging—operations where the work is supported on two mandrel blocks one at the back and one at the front of the press, and the fixed crosshead is then subjected to an increased upward bending stress due to the main cylinder reactions. The load diagram then becomes that of a beam having three upward loads, one at each cylinder, and two downward loads, one at each mandrel block, in addition to the minor loads already mentioned as being due to the balancing cylinders and to the weights.

EXCEPTIONAL CONDITIONS

A somewhat similar condition would occur if the top moving crosshead was brought down, under full press power, into contact with the stops fitted around the columns. This should not normally occur but is possible and the fixed crosshead must be capable of withstanding this condition. The line of load would then be along the line joining the centres of the columns, the two downward loads being applied at the column centre distance and the three upward cylinder reactions being applied at the centres of the cylinders.

A further condition which must be taken into account is that due to top and bottom tools being allowed to close at the full lowering speed without pressure being applied to the main cylinders. There would then be no balancing upward thrust due to these cylinders and the fixed crosshead would become a beam supported at either side of the foundation pit where it rests upon the concrete, and subjected in the centre to the full impact load due to the falling mass. The supporting feet formed on the fixed crosshead were therefore designed to withstand this load, plus the deadweight of the press.

As regards the material for the fixed-crosshead, it was first intended to make this of cast steel having the same properties as that of the two moving-crossheads, but owing to casting difficulties a fabrication from steel plate was finally decided upon. This is a large box section unit, adequately ribbed and weighing approximately 100 tons.

The resilient packings under the feet of the fixed-crosshead, in addition to helping to absorb the impact load discussed above, also compensate for any slight irregularities in the top surfaces of the concrete.

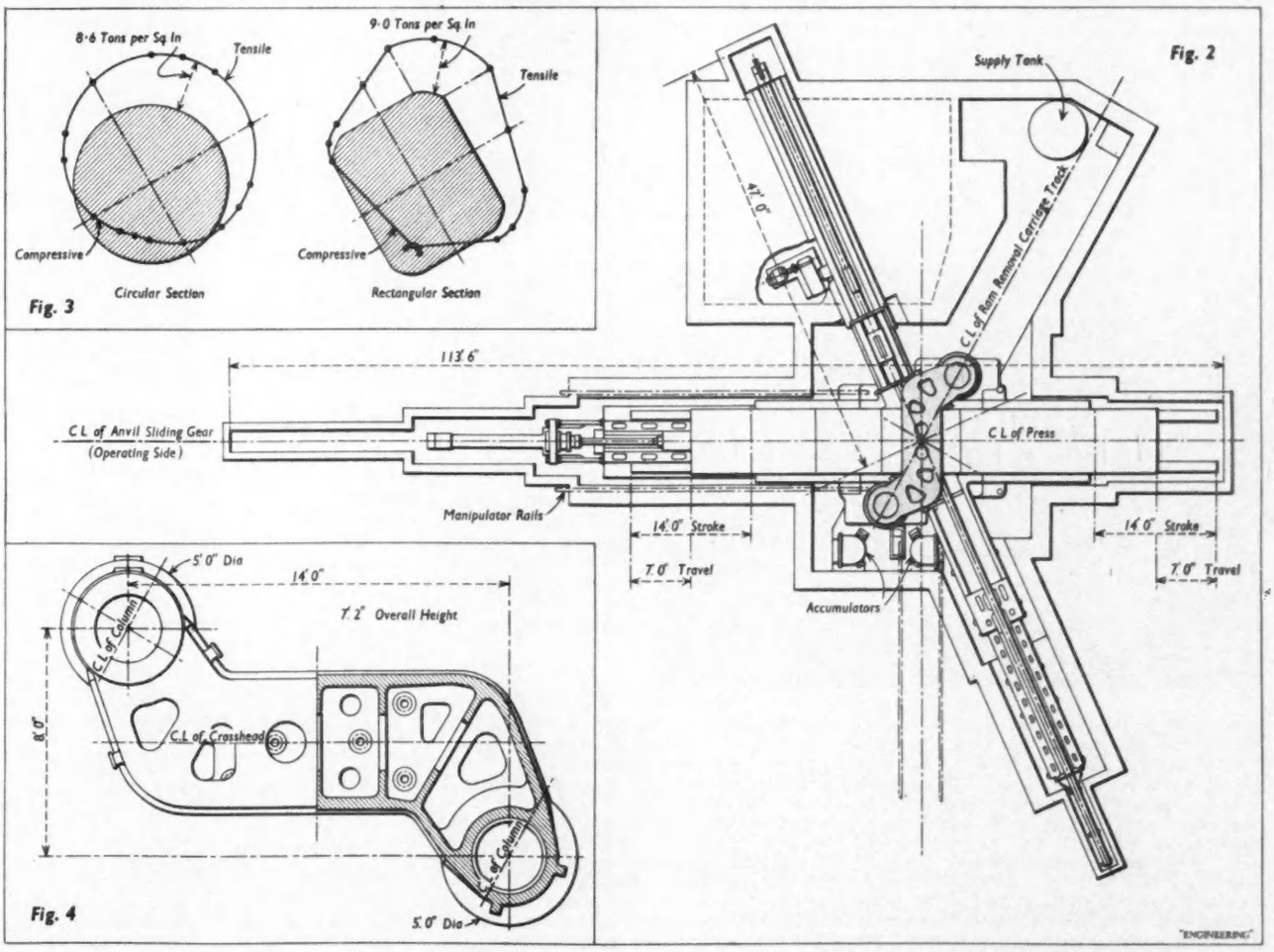
The main, lifting, and balancing cylinders follow fairly conventional practice in design and strength, but the lifting and balancing cylinders are somewhat unusual in that they employ single acting pistons with the pressure acting on the rod sides. This is done to keep them below ground level, away from possible damage and with all hydraulic connections away from the working area of the forge shop. In this position they must pull up on the bottom moving-crosshead, instead of pushing up on the top moving-crosshead as would be the case if they were mounted on the top side of the fixed-crosshead. Provision is made for air to pass in and out of the cylinders during operation together with any hydraulic oil which may leak past the piston packings.

The author wishes to acknowledge the assistance given by colleagues who formed a special group to study this project.

Fig. 2 Simplified plan of press layout.

Fig. 3 Stress values for maximum eccentricities.

Fig. 4 The top moving-crosshead.



Room of the Future

IT MAY come as an unpleasant shock to many people that the American "Family Room of the Future," which has been touring many centres in the States, is nothing more or less than a fallout shelter.

True it is tastefully decorated; the American Institute of Decorators, who presented it, have seen to that, but that does not entirely conceal its sad implications. As an example of getting the most out of a confined space, however, it can have few equals. Measuring 8 ft 6 in by 12 ft, it is designed to house four persons for a long period, but it is to be hoped that the whole of the 40 year calendar that hangs on one wall will not be needed.

The room illustrated here was designed by Mr. M. T. Nielsen and conforms to all requirements of the Office of Civil and Defense Mobilization. Other designs have greater or less equipment for comfort. The construction is imagined to be in the basement of a dwelling so that a certain amount of protection is already present. The construction is strong enough to give protection against hurricanes and tornadoes as well as fallout, and the design is intended to allow the room to be used for normal living or recreation when not required for its ultimate purpose.

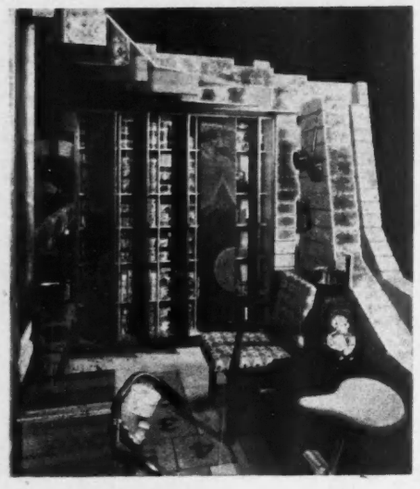
In the foreground can be seen a skeleton bicycle that will provide the family with exercise and also drive an exhauster for the air circulation. It would seem possible to drive a dynamo from it also for battery charging but this is not mentioned in the original design. Other physical recreation is provided by having a hop-scotch court inlaid in the floor.

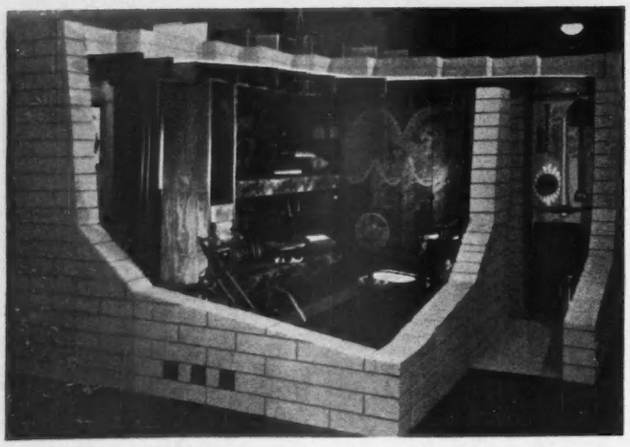
The cupboards at the back, which have revolving doors of walnut decorated with a map of the world, will contain enough food to keep the four people supplied for a fortnight. Water is stored in a tank in the cubicle on the left, mounted above a small sink. In the extreme left corner is a toilet designed primarily for water flushing but which can be converted for use with chemicals if necessary. Below and in front of the sink is stored a folding table that can be pulled forward into the centre of the room for meals or for activities needing a working surface. The folding door of the toilet is arranged to be used as a blackboard when closed.

mentioned for this room but in the general advice booklet a flashlamp bulb powered by batteries is suggested to give a continuous low level of illumination. Since only radiation is being considered and not local bombing with high explosive, it is accepted that mains electricity supplies will probably be available. This source is also suggested for heating, although some alternative means would seem advisable.

A most important item is the radio set, for by radio messages and instructions will be distributed. The illustrations also show a television set which would undoubtedly help to pass away the time—provided there was any transmission. Curiously enough, there is no mention of a clock, although some long period battery driven model would seem a good idea especially for timing the all important radio instructions. Wrist watches can be damaged in an emergency.

Other essentials in the shelter include first-aid and medical kits. Outside, in the entrance passage, are digging tools and such useful items as a coil of rope and a flash light. Waste bins can also be stood here. It is estimated that





(Above) During the day exercise is provided by a cycle, which also pumps air through the room, and by a hop-scotch court marked on the floor.

(Left) Built in the basement, the room of the future will protect four people against fallout hazards. This view shows the beds drawn out for the night.

At night, as shown in the larger illustration, the trundle bed is pulled out from under the couch and the upper bunk let down from the ceiling above the couch where it is normally stored. The fourth bed is made up on the divan in the foreground. There is little room to spare between the beds but they are all full size. Below the divan are storage drawers.

A small cooking range that can be fired by bottled gas (possibly also by oil) is just inside the entrance. It stands on a folding table beneath which folding chairs are stored. Lighting is not

radiation intensity is reduced to 1 per cent of its initial value in a period of 49 hours, and while this may still be dangerously high, it would seem that the period of incarceration should not exceed four or five days.

The fittings of the room offer a challenge to the designer to make them as compact as possible. The caravan has many similar problems and so has the small boat. But neither of them is expected to house the owners continuously for several days without any going out at all. That problem is unique to the shelter.

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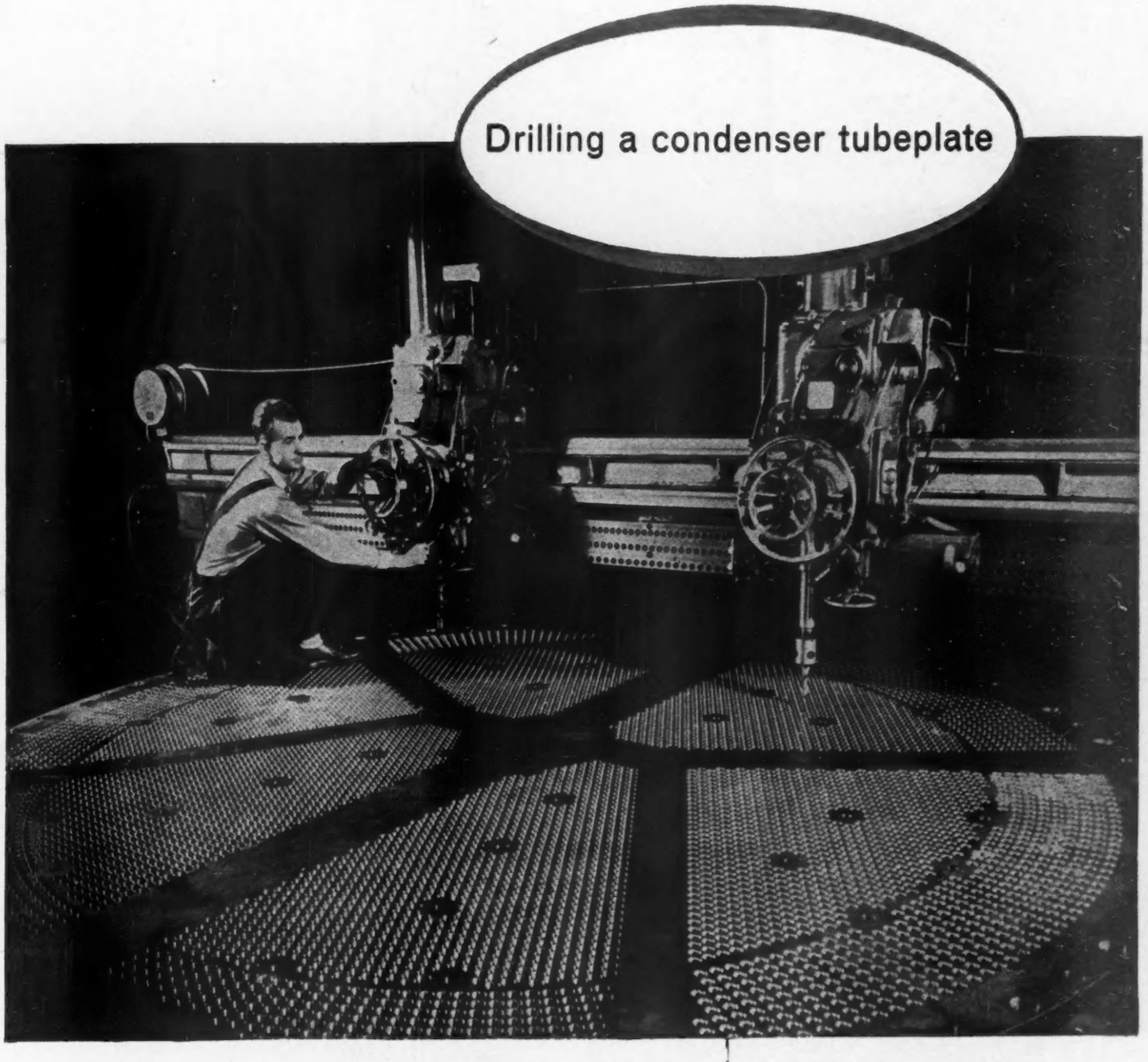

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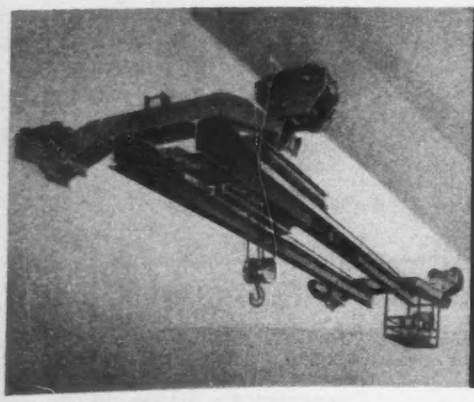

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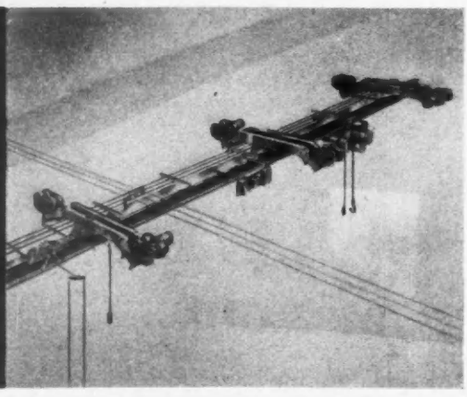

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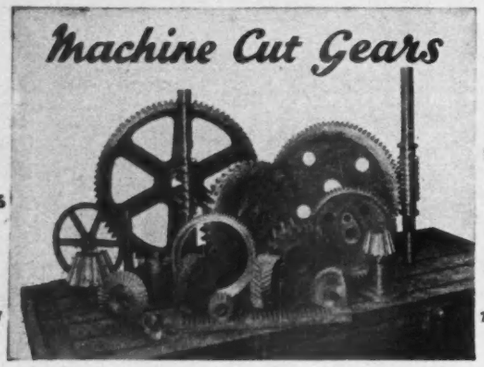

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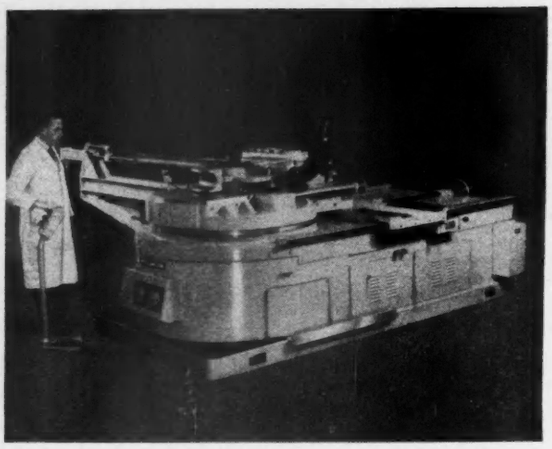
★ Produces full bore bends, free from wrinkling, cold and unfilled on standard or short radii.



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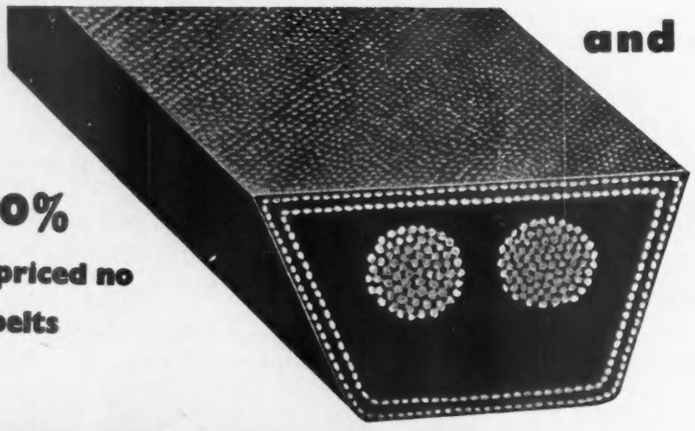

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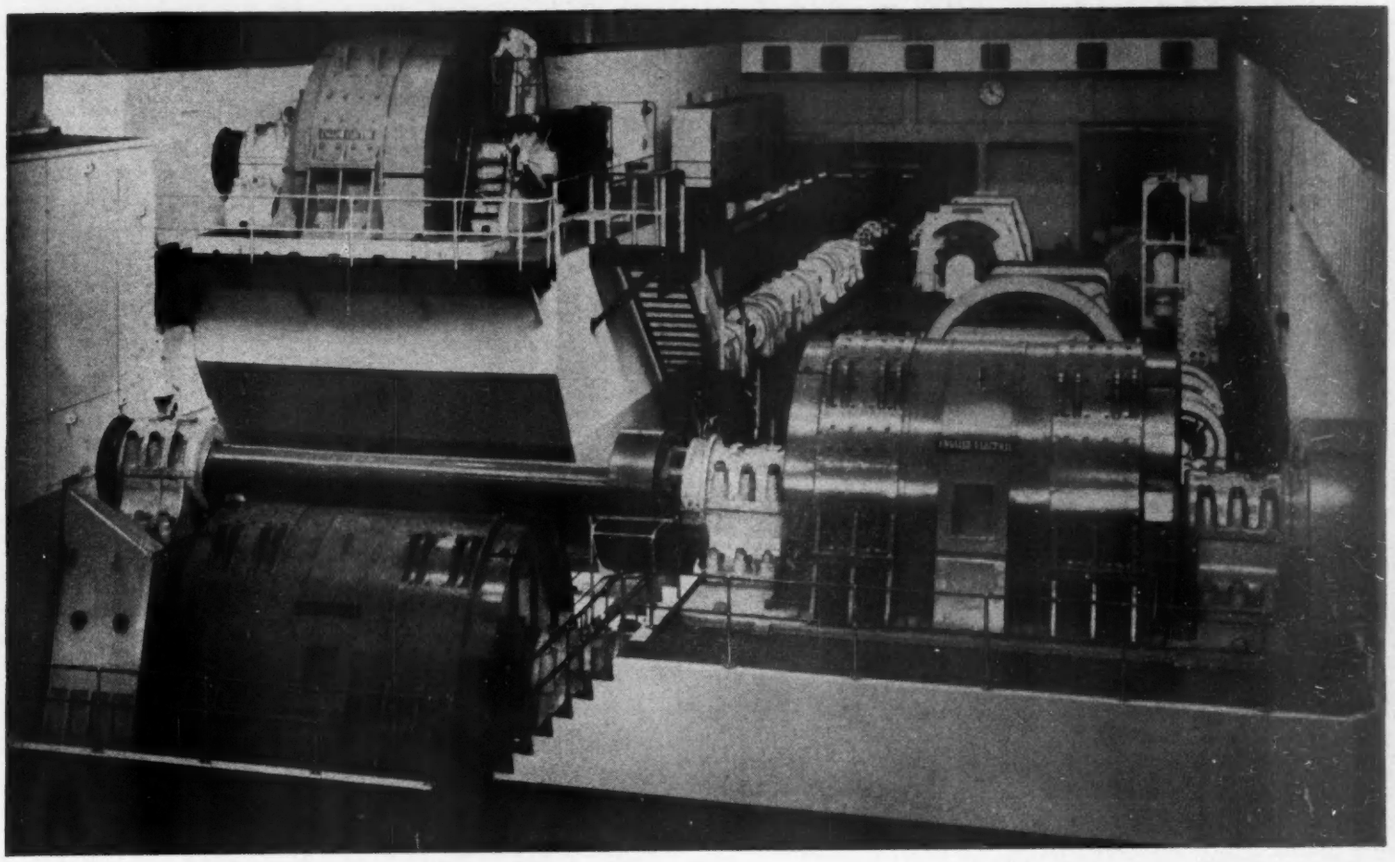

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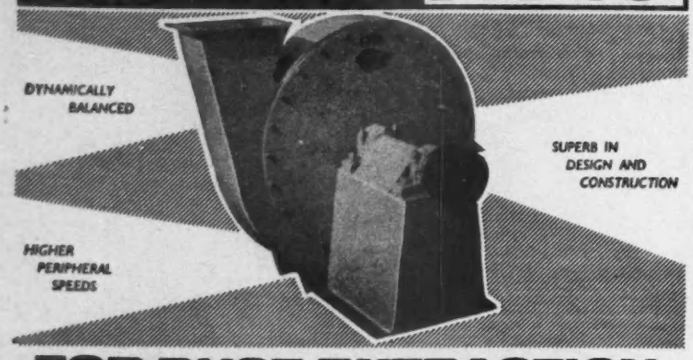

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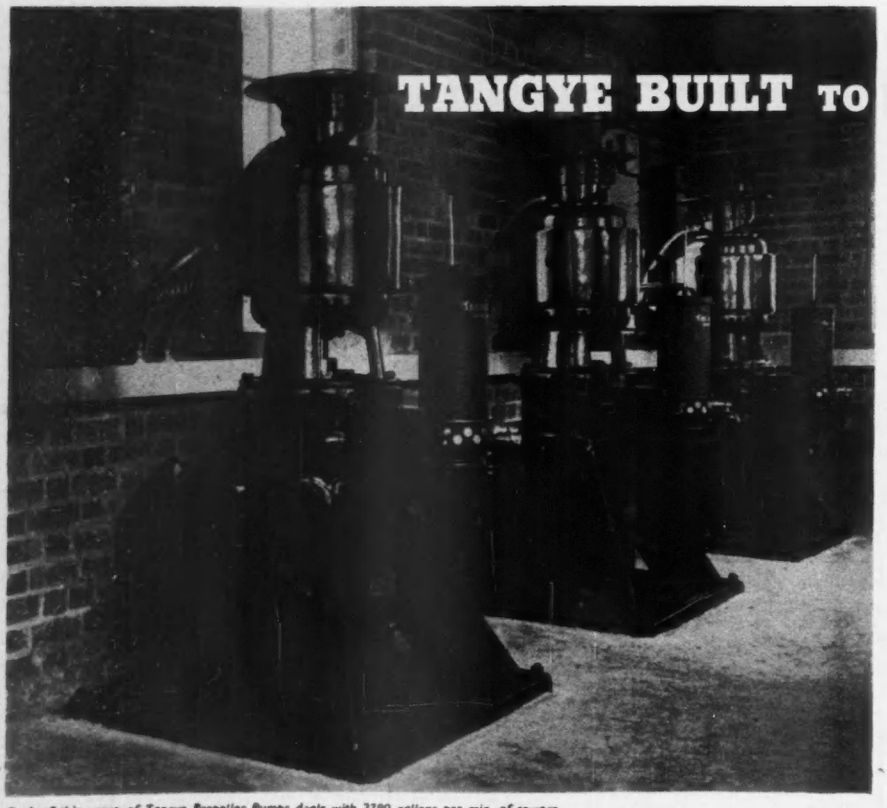

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Each of this group of Tangye Propeller Pumps deals with 2780 gallons per min. of sewage effluent, against a 10½ feet head. Driven by a 15 B.H.P. motor running at 720 R.P.M.

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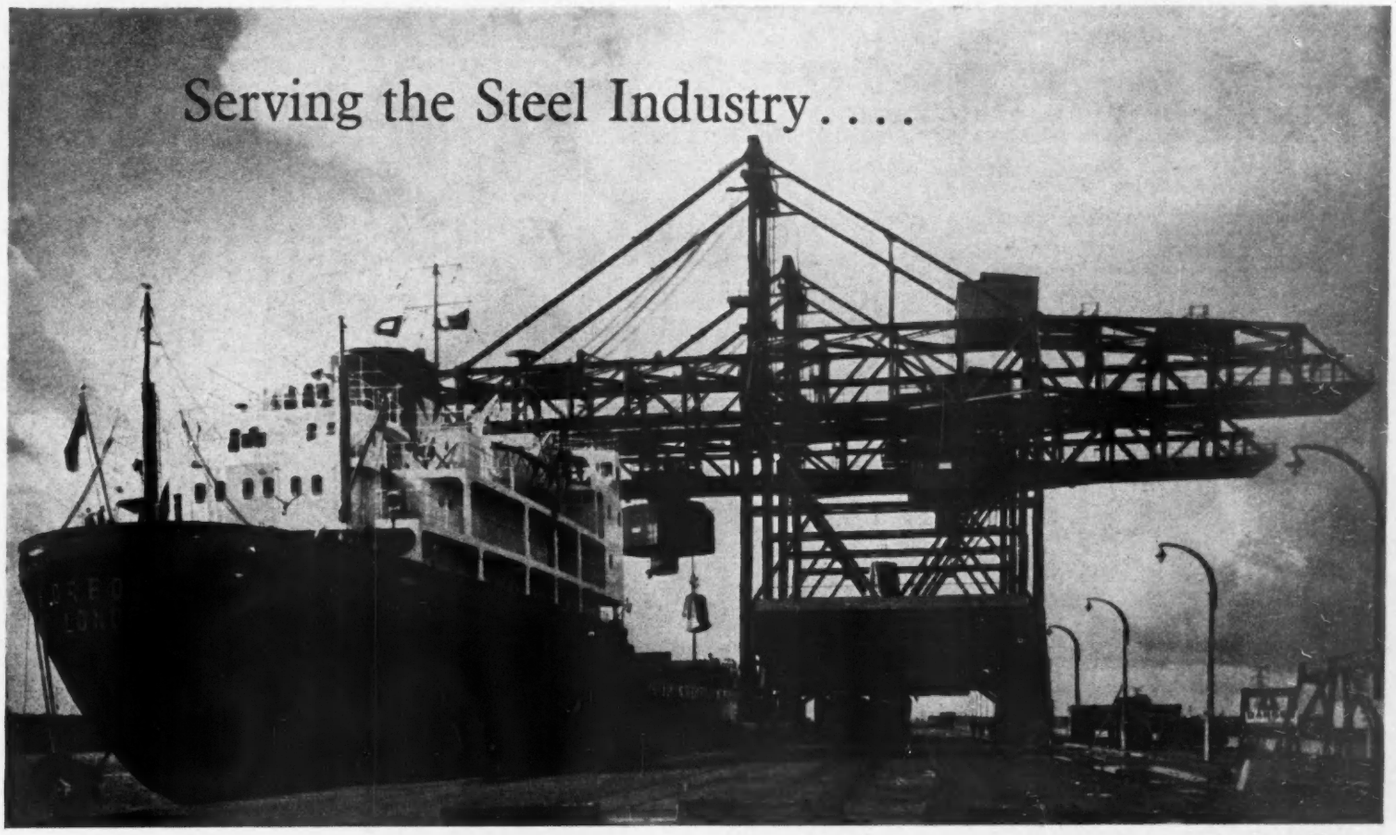

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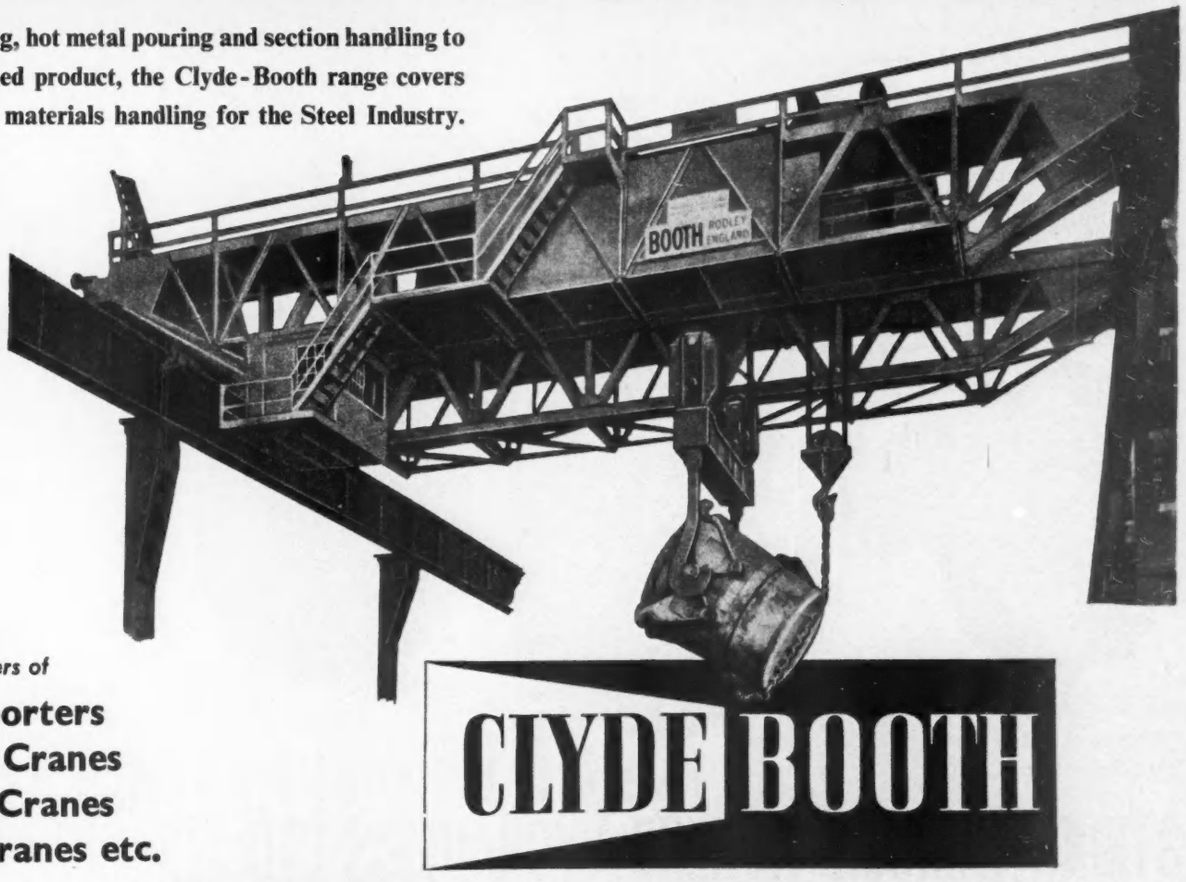

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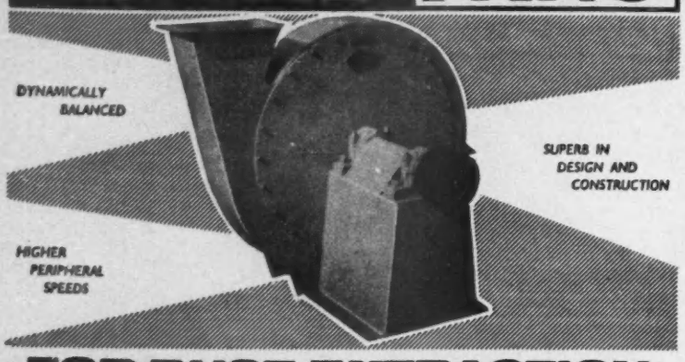

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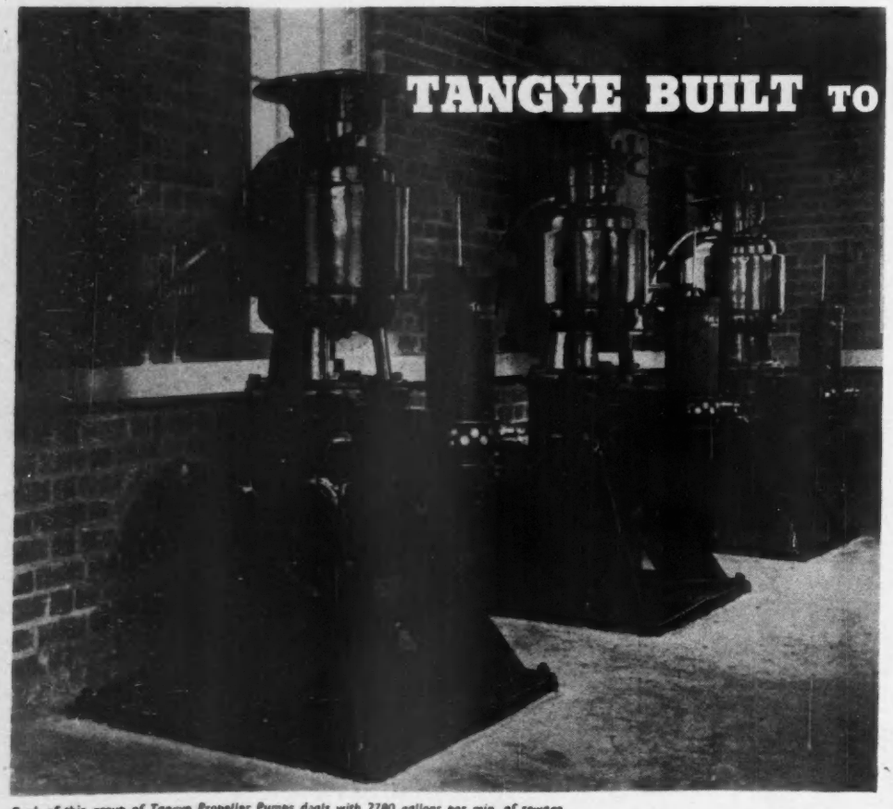

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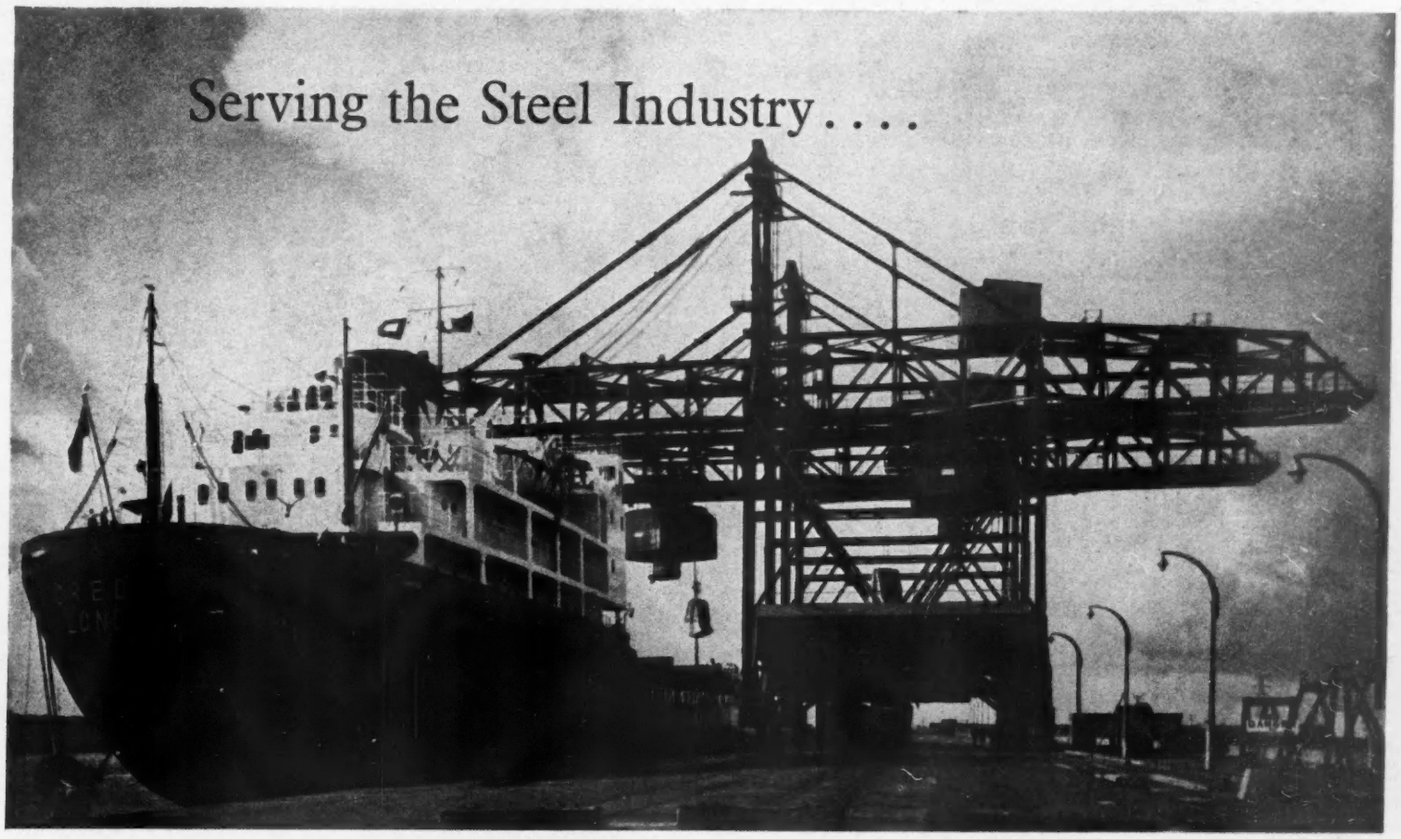

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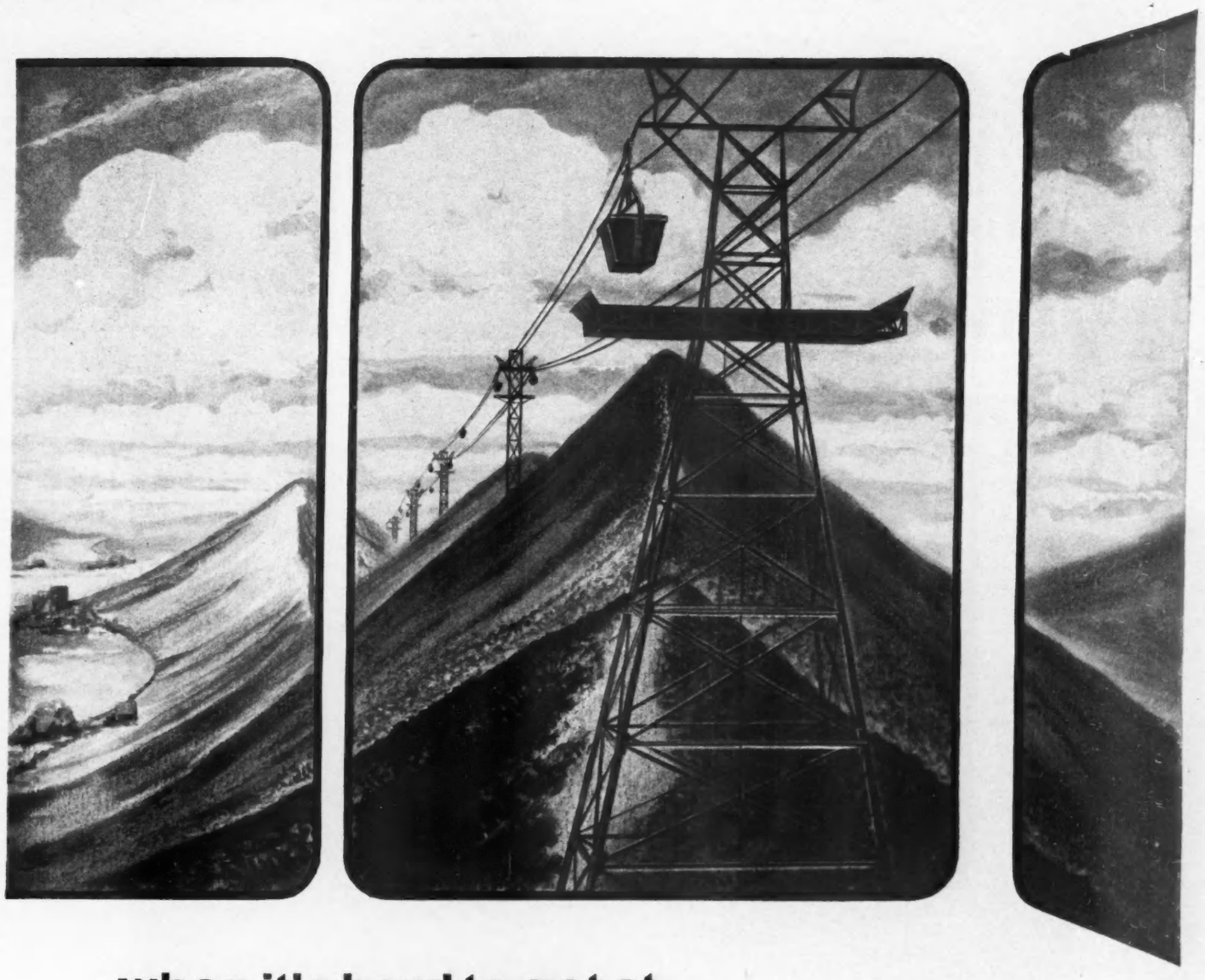

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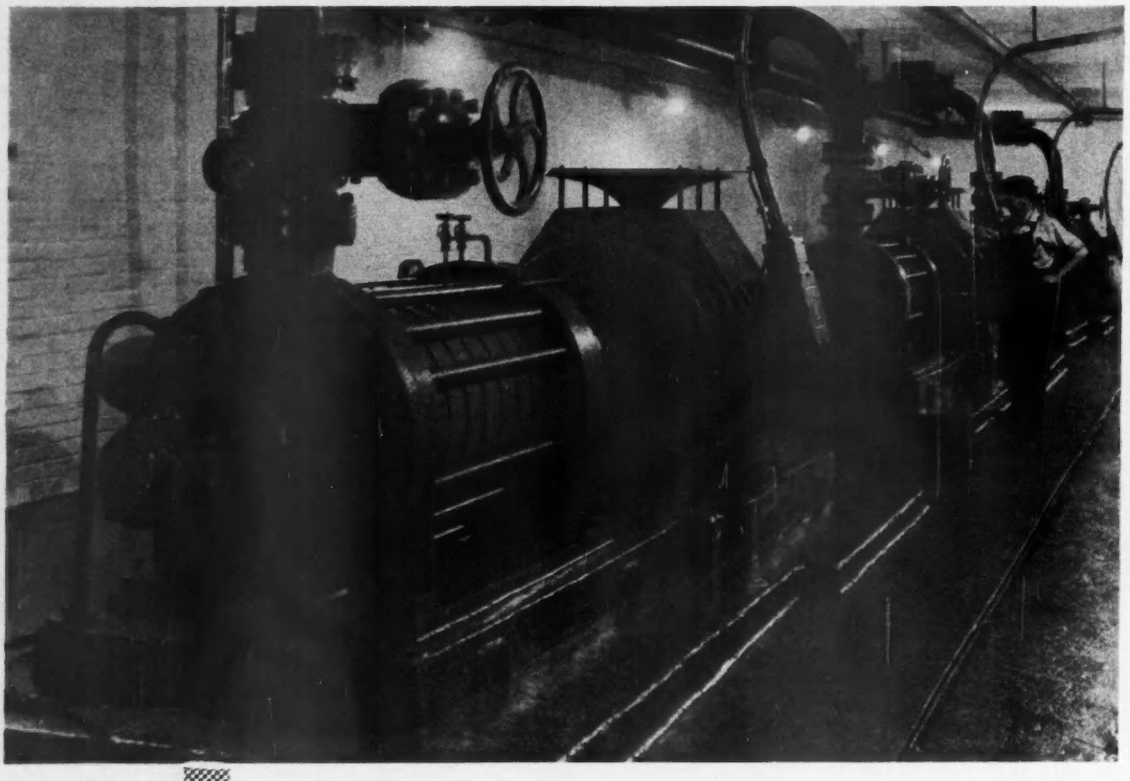

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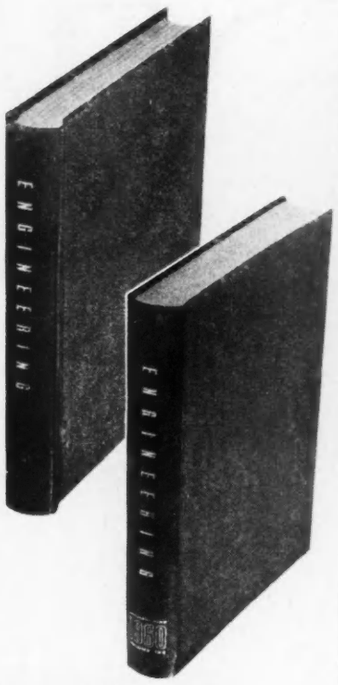

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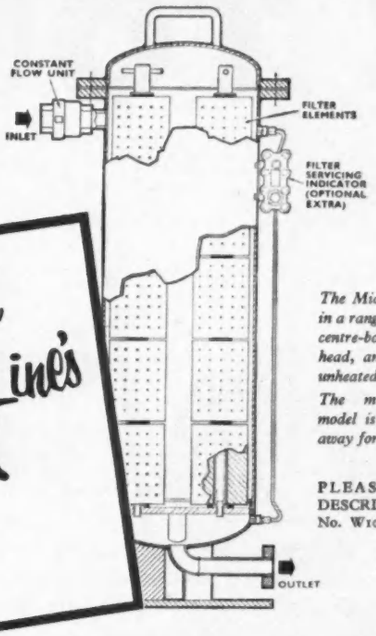

The Micro-Pak is available in a range of capacities, with centre-bolt or multi-bolt head, and either heated or unheated.

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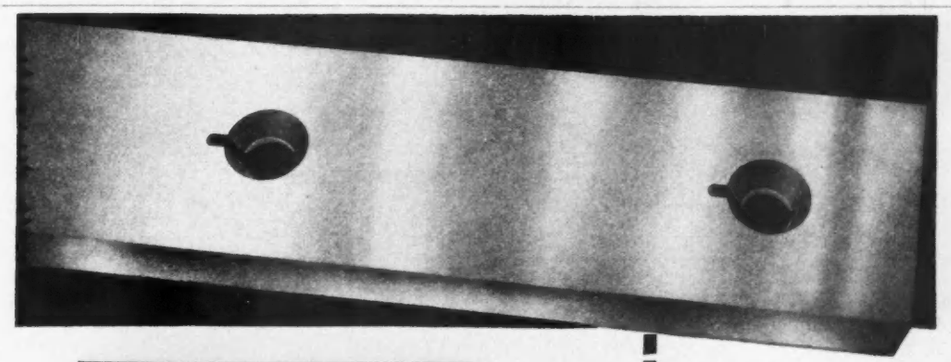

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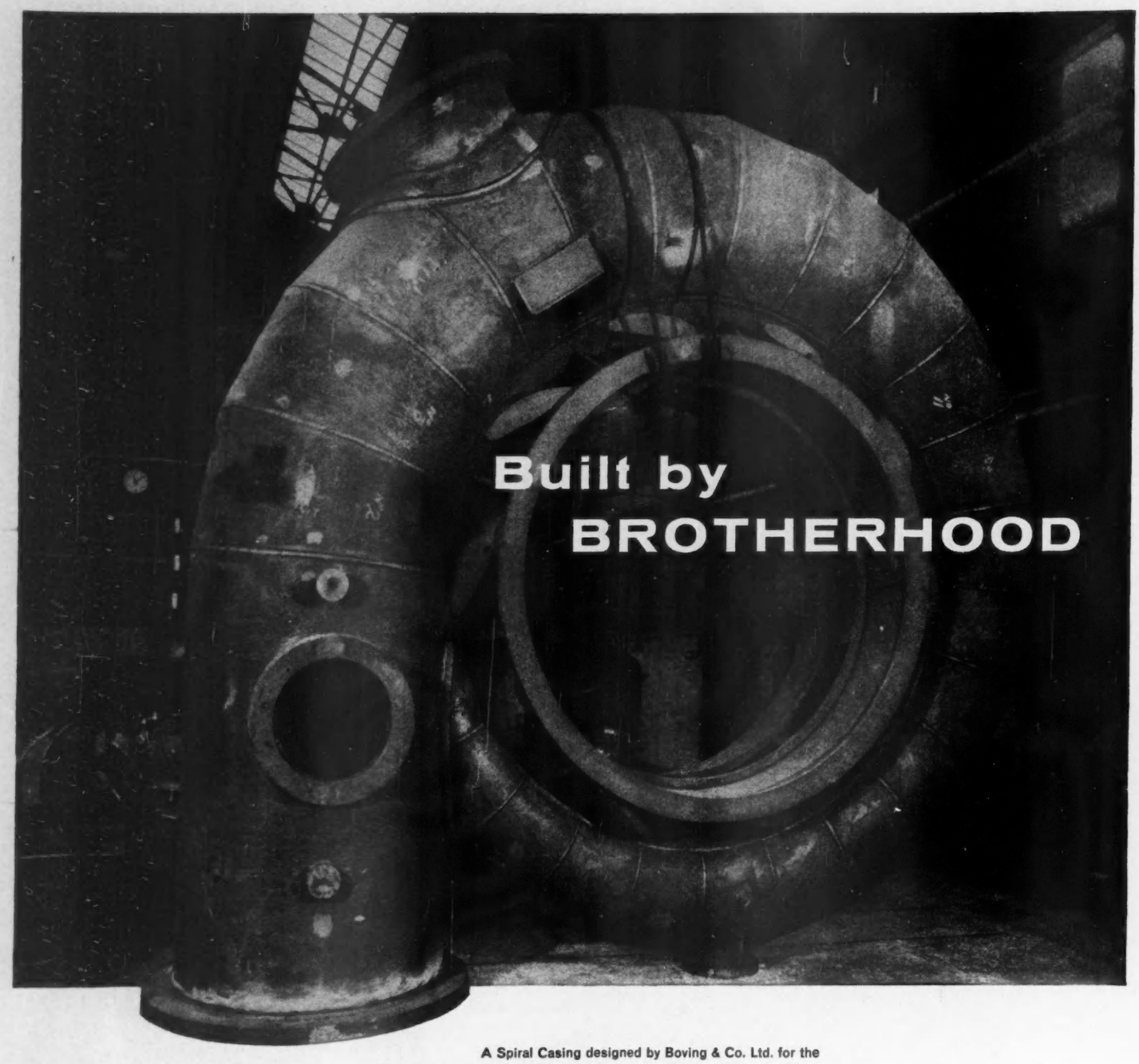

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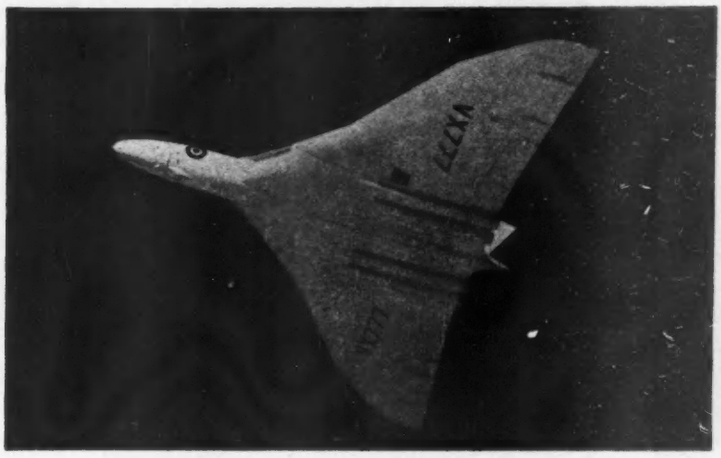

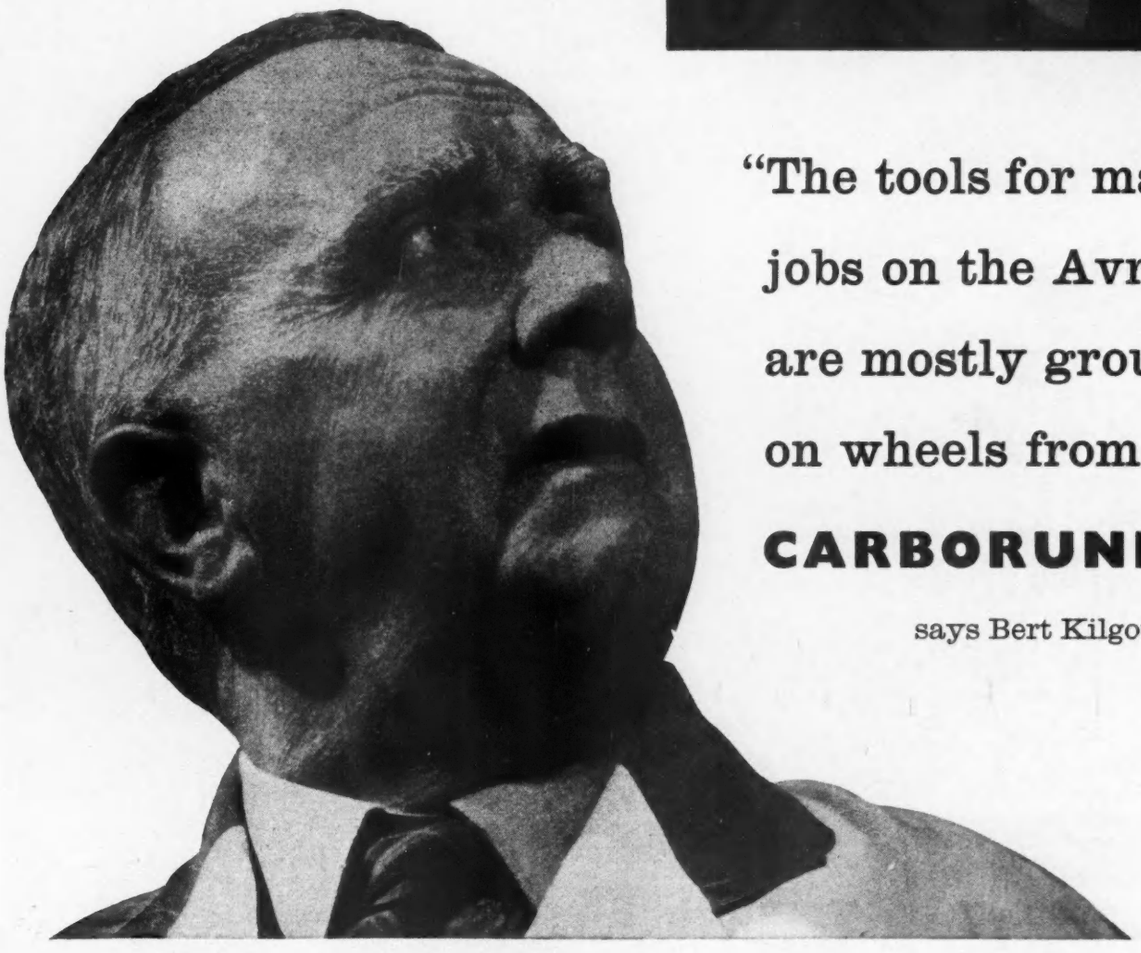

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says Bert Kilgour

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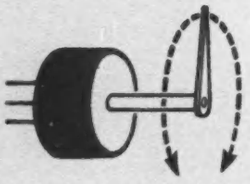
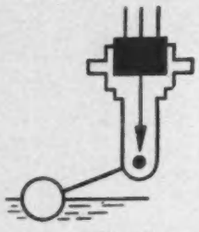
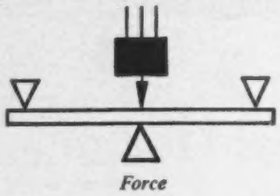


Angular Position

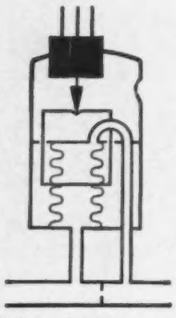


Fluid Level

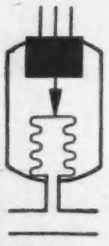


Force

Linear Position



Differential Pressure



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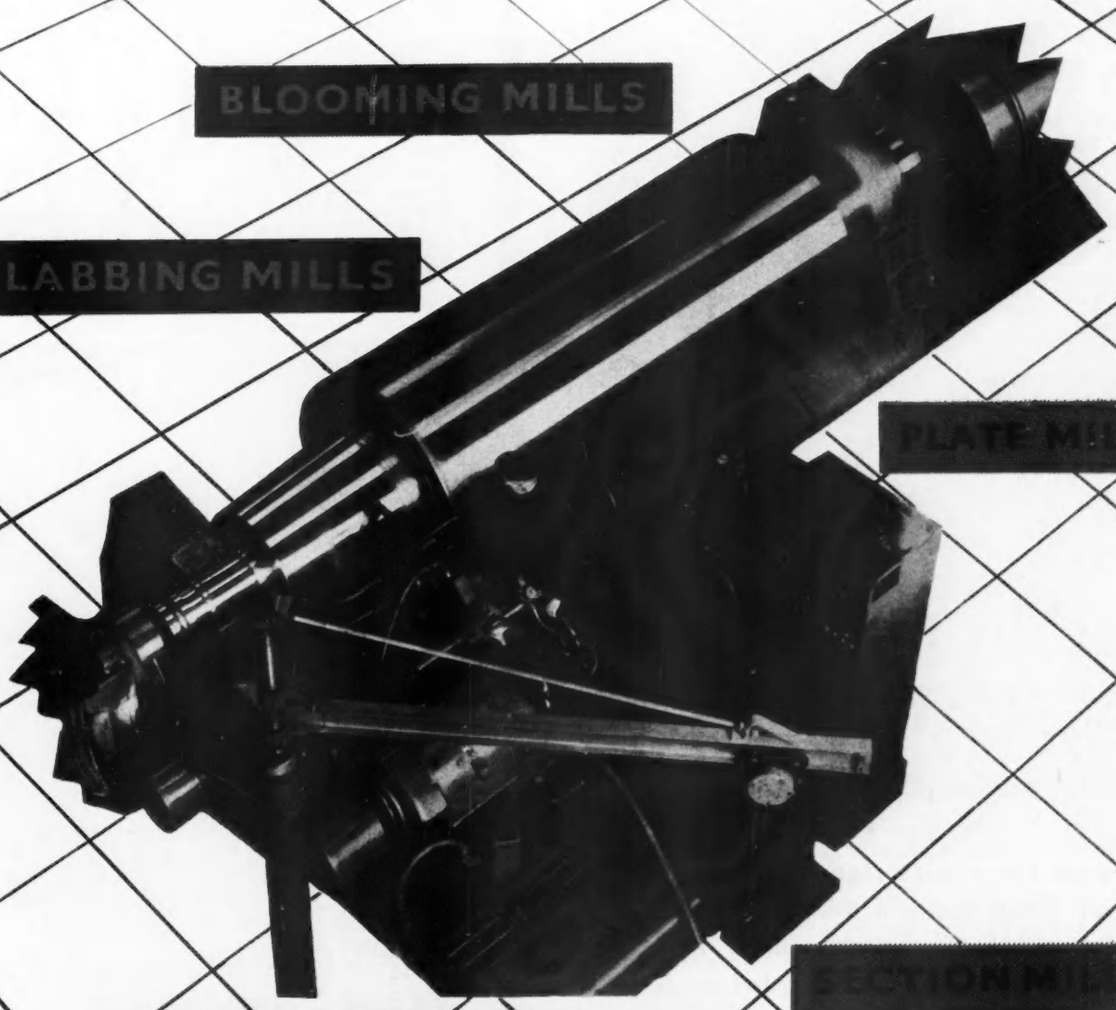

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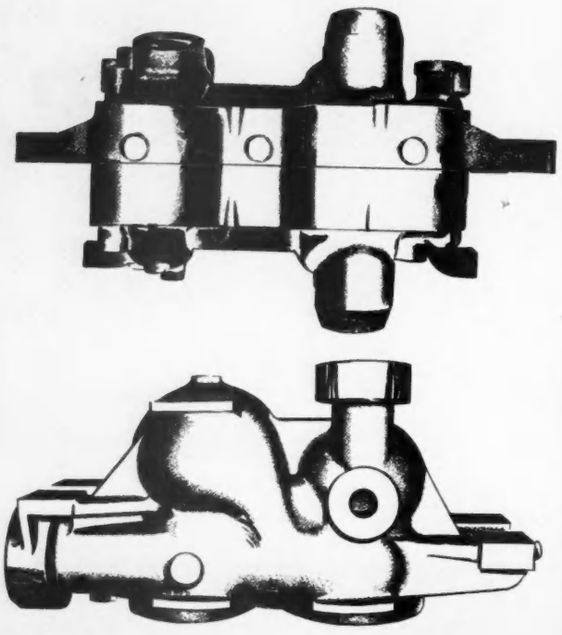

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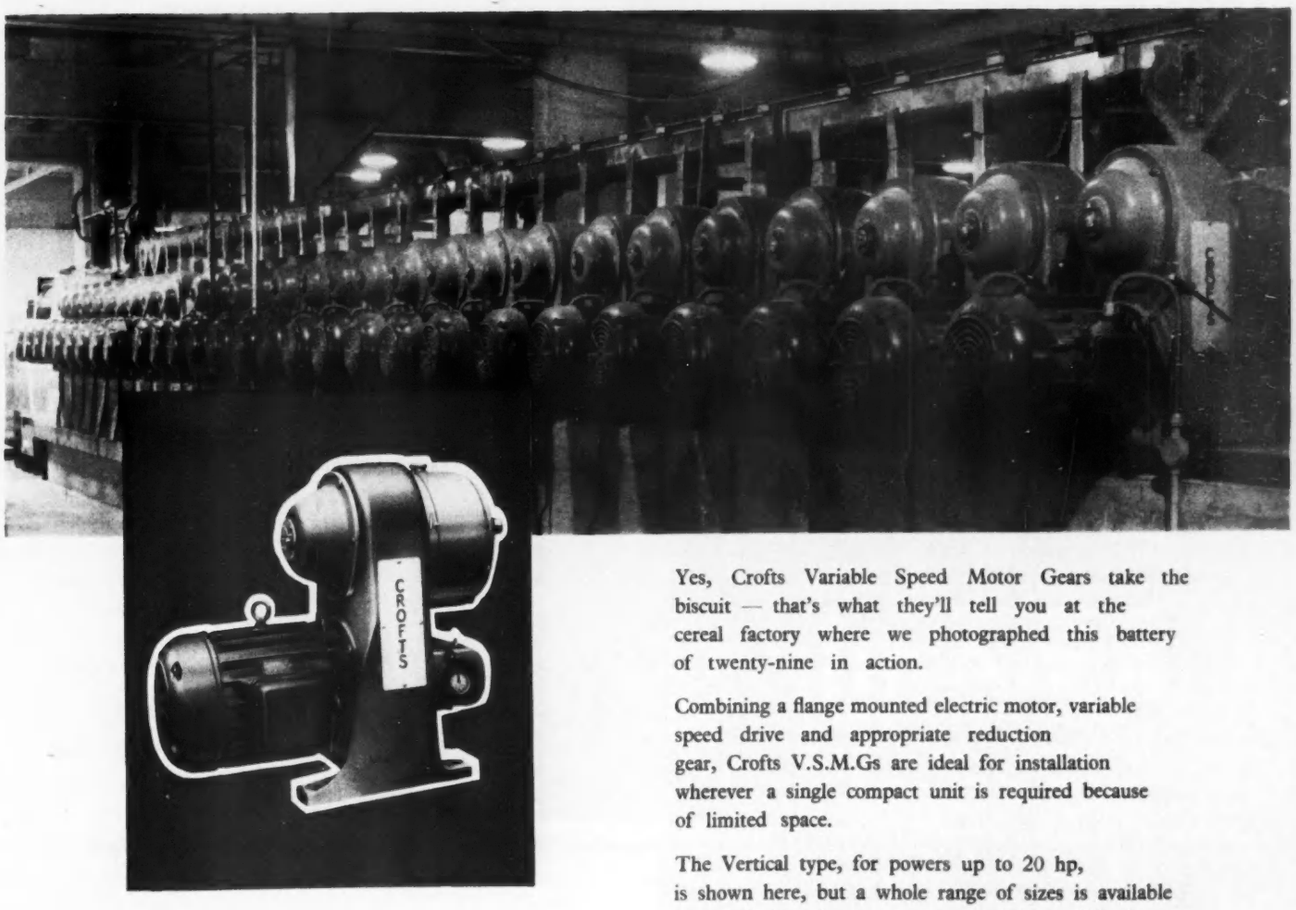

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The Vertical type, for powers up to 20 hp, is shown here, but a whole range of sizes is available and one's bound to suit you. Send for publication 560 giving all the information you'll require.

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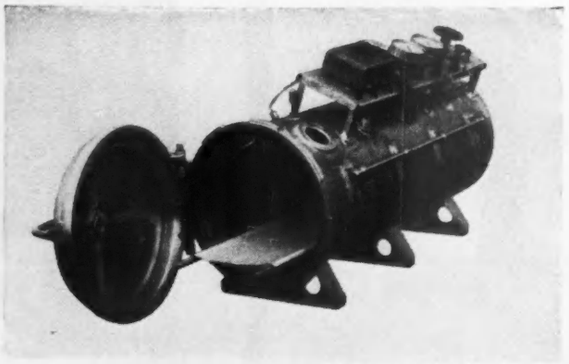


Photo: courtesy SARO (Anglesey) Ltd.

RECOMPRESSION CHAMBERS

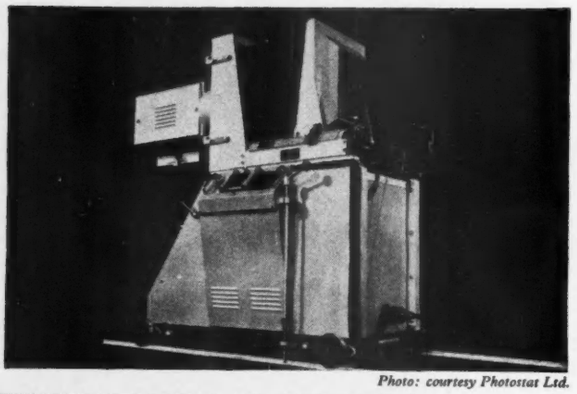
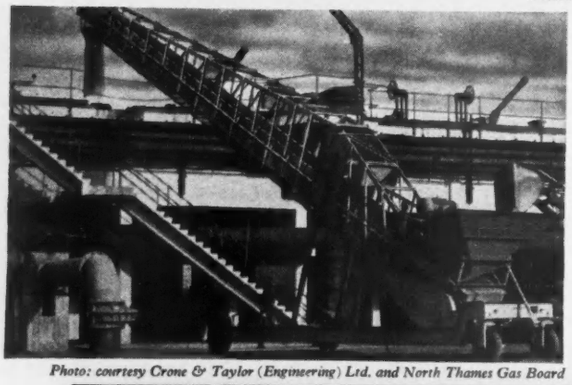


Photo: courtesy Photostat Ltd.

PHOTO-GRAPHIC EQUIPMENT



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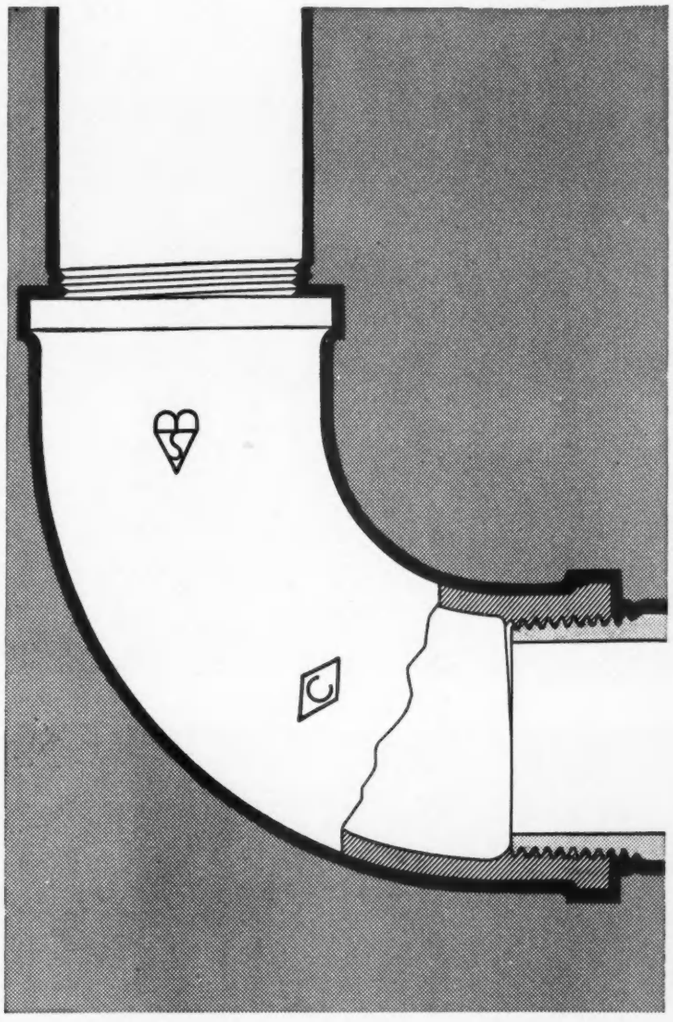

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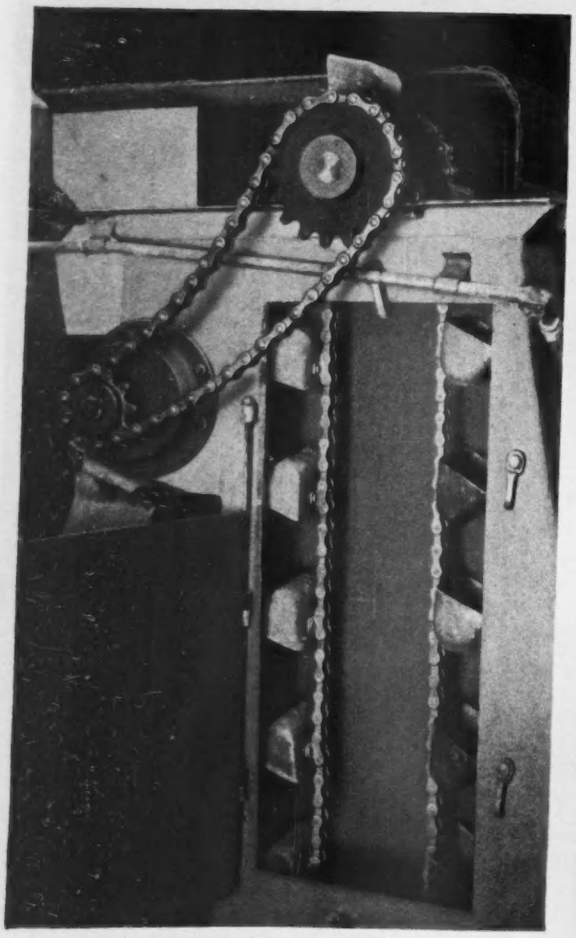
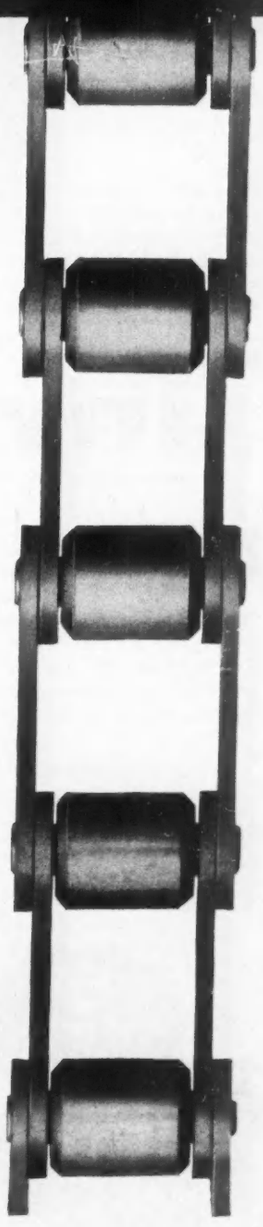


Tin Plating machine: Malleable chain on this machine had only one month's life; photograph shows MARK 5 chain after 12 month's continuous service

Sand Conveyor: Mark 5 chain operating under arduous conditions eliminated frequent replacement of previous malleable chain

Lime spreader. Strong, corrosion-resistant Mark 5 chains withstand the adverse conditions inherent in this application

THE COVENTRY MARK 5



The Coventry Mark 5 steel roller chains are the modern replacement for malleable detachable chains. They are particularly suitable for applications where proper attention as regards lubrication, alignment etc. cannot be given and where conditions are wet, dusty or humid.

Higher tensile strength to avoid breakdowns

The Coventry Mark 5 chains have the same tensile strength as alloy steel chains — much higher than malleable or pressed steel chains.

Longer wearing

Hardened bearing surfaces provide increased resistance to wear and smooth-running rollers minimise friction.

Corrosion-resistant

Every component has a non-ferrous metallic coating to guard against rust.

Attachments for conveying duties

K1 and M1 attachments lugs can be fitted to any chain, at any pitch spacing, one or both sides.

Eight standard sizes

The Coventry Mark 5 chains are made in eight standard pitch sizes — 1·15″, 1·375″, 1·5″, 1·63″ (2), 1·65″, 2·297″ and 2·609″ — replacing malleable chains Nos. 32, 42, 45, 52, 55, 57, 62, 67, 75, 77, 78 and 88. They will run on the same wheels as the malleable chains they replace, although for best service it is recommended whenever possible to run the chains on the associated Mark 5 wheels which are available in a wide range of sizes.

THE COVENTRY MARK 5 STEEL ROLLER CHAINS — THE IDEAL REPLACEMENT FOR MALLEABLE CHAINS

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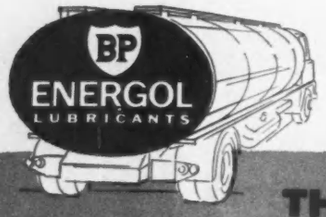

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Electrical Aids in Industry *Data Sheet* **No. 11**

Dielectric Heating - 2

The ability of dielectric heating to generate heat through the mass of a suitable material provides the following considerable advantages over other heating methods.

1 A body of uniform section and composition is raised in temperature uniformly throughout. Hence there is no waiting for heat to be transferred from an external heat source to the surface of the body and thence to its interior, and this is of particular advantage when the body is thick, and, as is often the case with dielectric materials, has poor heat-conducting properties.

2 The rate of heating of such bodies is, therefore, much faster than by external heating methods.

3 Since there is no external heat source, overheating or burning of the surface of a heat-sensitive material is avoided.

4 High thermal efficiency is achieved.

5 The amount of heat generated in the work is usually predictable and power input and heating time can be under positive control.

6 Production can start immediately after switching on, and no current is used, nor heat lost, during periods of shut-down.

7 Vastly increased productivity is obtainable with less labour (usually unskilled), and fewer machines and less floor space are required.

8 Flexibility of layout makes it possible to plan the factory to best advantage, as dielectric heating equipment can usually be inserted directly into the production line.

Dielectric Heating: typical application data

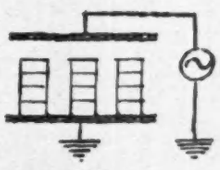
Typical application	Frequency	Radio frequency power
Thermoplastic welding.	20-100 Mc.p.s.	Up to 1 kW
Plastic preheating, wood glueing.	10-40 Mc.p.s.	2-30 kW
Plywood manufacture.	2-10 Mc.p.s.	Above 30 kW

Note: 1 Mc.p.s. = 1,000,000 cycles per second.

A few of the industrial applications of dielectric heating are briefly described below.

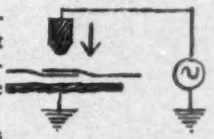
Preheating Thermosetting Plastics

Dielectric heating is the ideal way of preheating moulding powder pellets used in the production of thermosetting plastic mouldings, since these materials are generally poor heat conductors. Properly applied, dielectric preheating promotes faster curing and hence a shorter moulding time, often increasing production ten to fifteen times. There is a marked reduction in tool wear, and thicker sections can be moulded, as the material is plastic when placed in the mould. There is less damage to, and movement of, metal inserts.

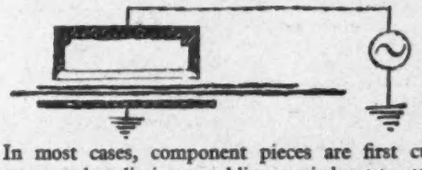


Welding of Thermoplastic Materials

An important and extensive application of dielectric heating in the plastic industry is the welding of thermoplastic sheets in the fabrication of such commonly used articles as raincoats, hoods, handbags, pouches and packaging materials. Dielectric heating is the only method which can usefully be employed, since the heating electrodes, and hence the outside sheet surfaces, remain cool while the inside surfaces forming the joint are fused, and a perfect weld results.



Two or more thermoplastic sheets are welded under pressure from electrodes suitably shaped to the area of weld required, the current being switched on at the same time as pressure is applied, and off as soon as the weld is completed and the pressure released. Stitching is thus eliminated and a far stronger joint achieved.



In most cases, component pieces are first cut from patterns and preliminary welding carried out to attach any fastening tabs and the like. The pieces are then brought together in a suitable loading frame and the main welding carried out to produce the complete article. In some cases, a suitably profiled electrode can be fitted with a knife edge to cut the sheets immediately outside the weld line, welding and pattern-cutting being thereby carried out in the one operation. Dielectric welding can be applied also to very large thermoplastic products such as linings for swimming pools, and cinema screens.

Drying

Drying of materials by dielectric heating has the great advantage that the material tends to dry out from the centre, the reverse of what happens when external heating methods are employed, and the risk of overdrying and overheating of the surface is eliminated. In general ½ to 1 unit of electricity is required to drive off 1 lb. of moisture, depending upon the thermal properties of the material being dried. While the removal of large amounts of water from inexpensive commodities may sometimes be uneconomical, dielectric heating in the production line often leads to a higher overall production efficiency. It is valuable for removing final moisture traces and becomes increasingly economical as the value or heat-sensitivity of the commodity increases.

Rubber

External heating tends to dry and cure the surfaces of a thick latex mass before its centre, but dielectric heating properly applied promotes uniform conditions throughout.

Loaded rubber may not heat uniformly in a dielectric field due to uneven dispersion of its load, but nevertheless rubber preforms loaded up to about 15% are preheated dielectrically to reduce moulding times appreciably, the temperature evening out in the mould to give uniform curing.

Further examples are given in Data Sheet No. 12.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone : TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available — "Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

4774-1

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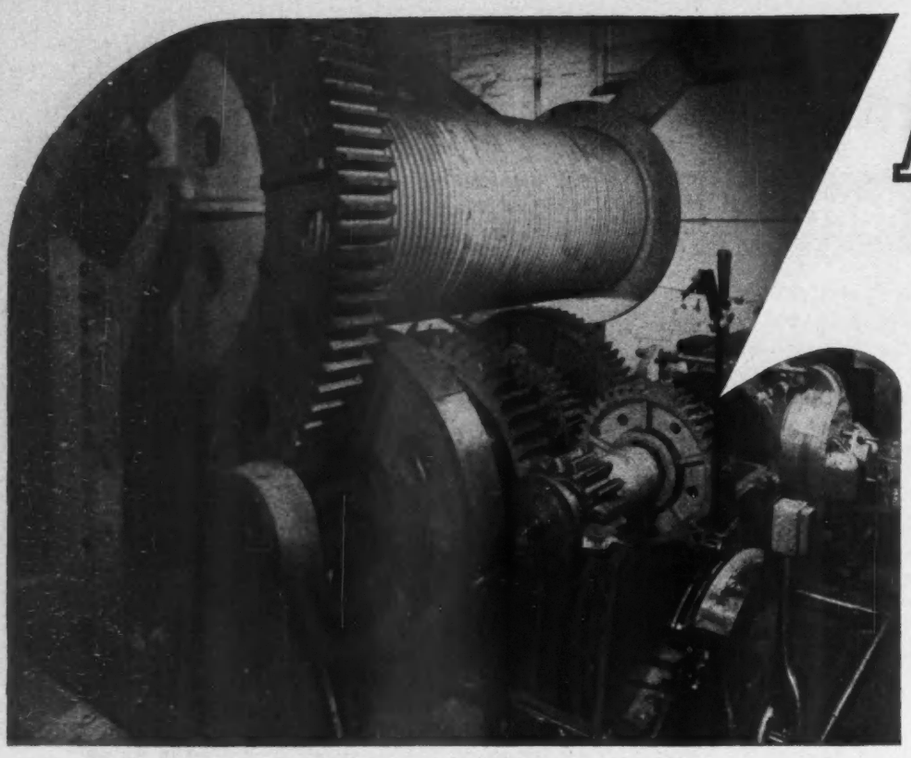

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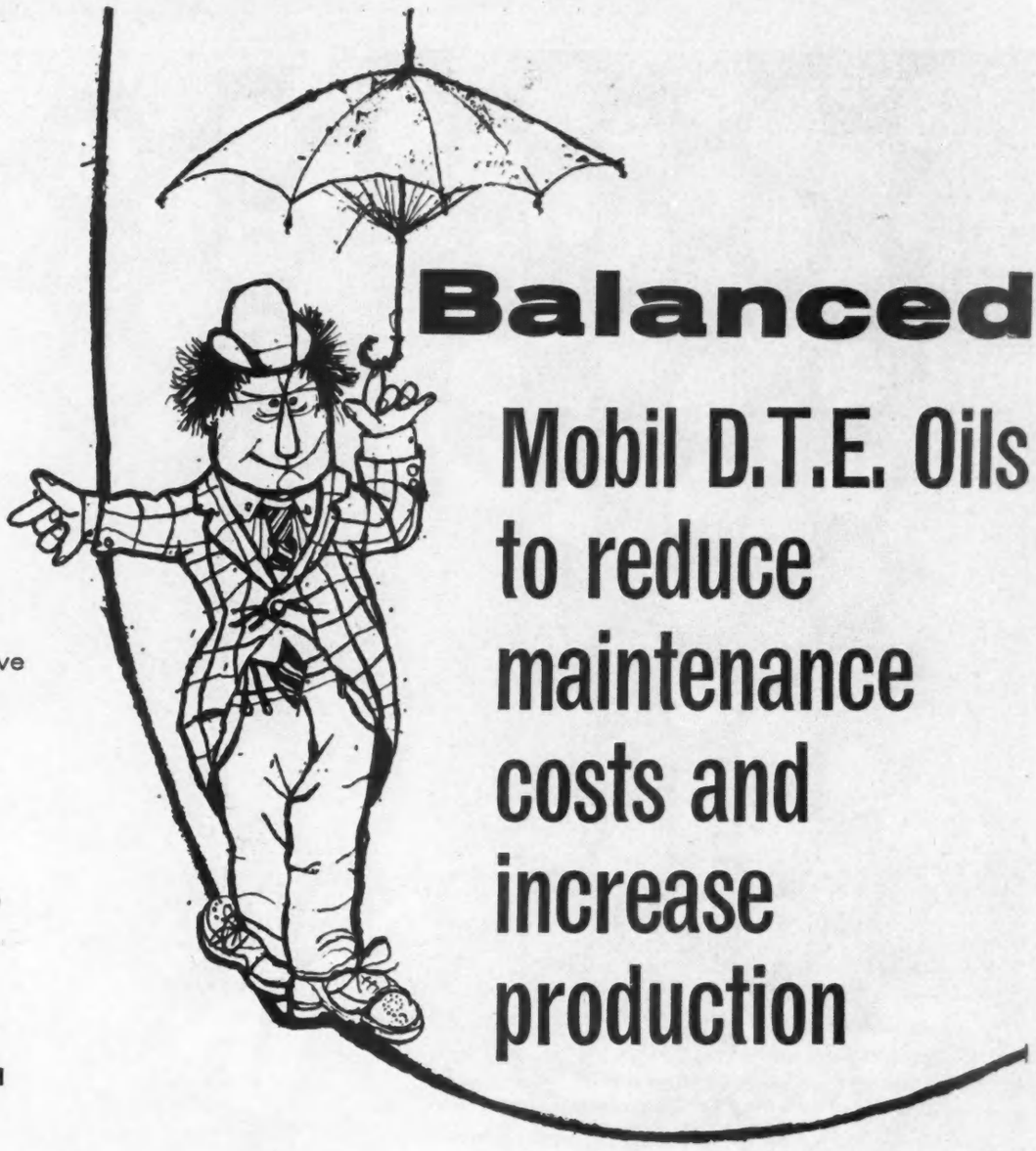

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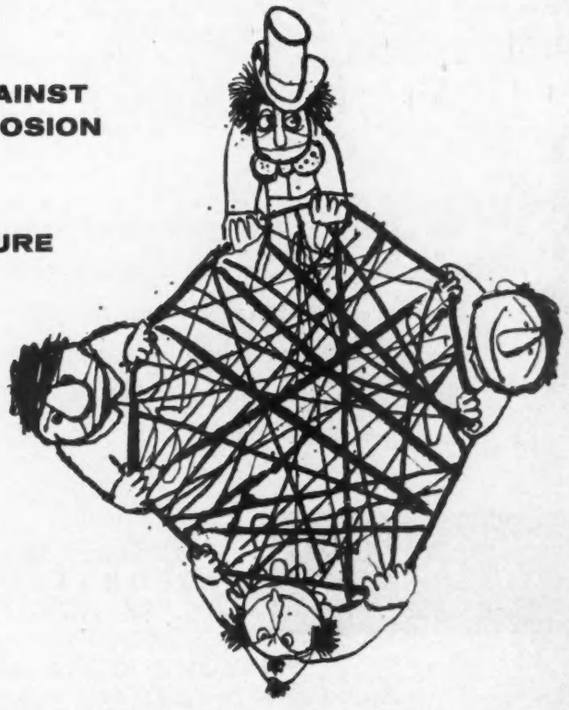

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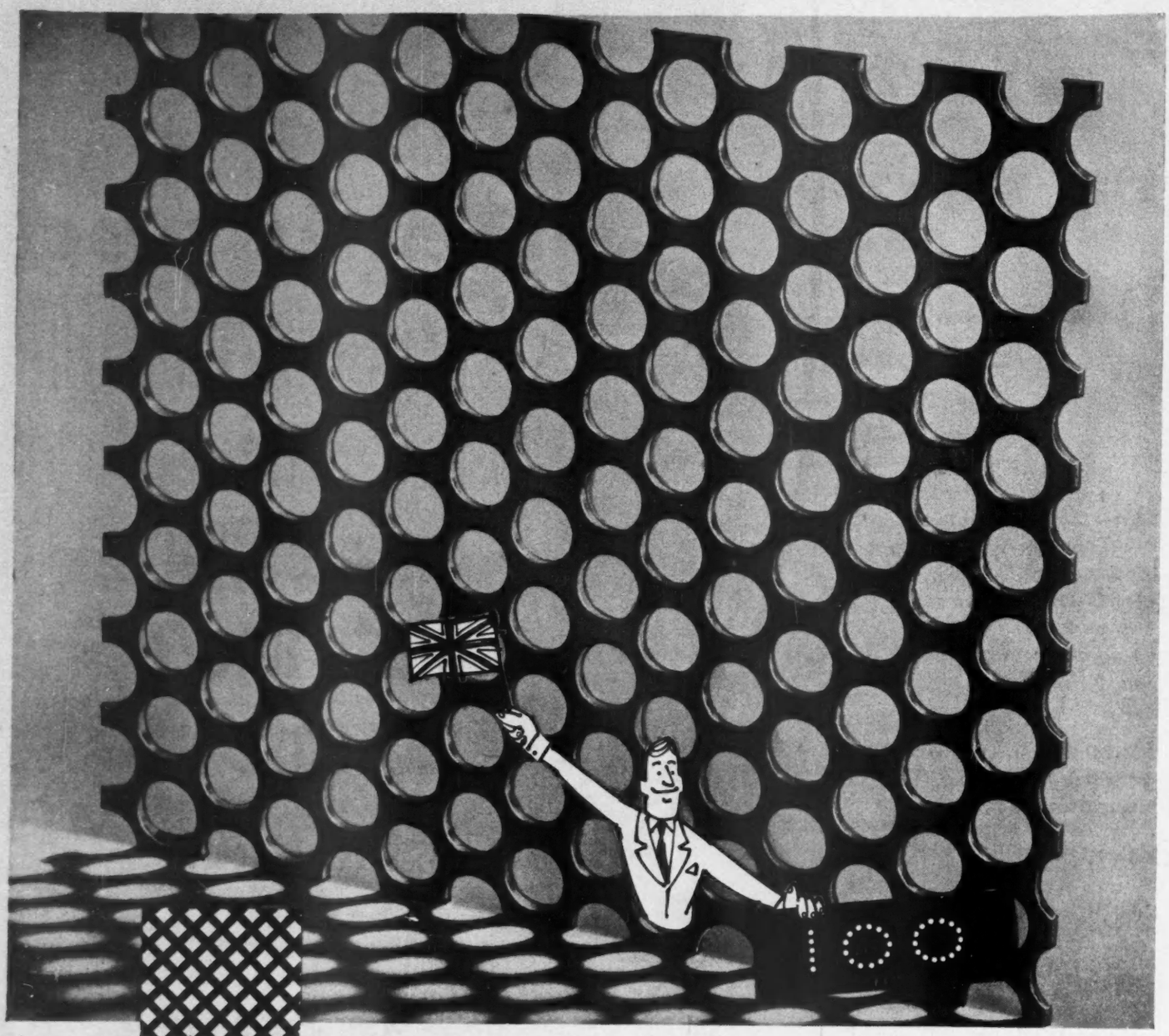

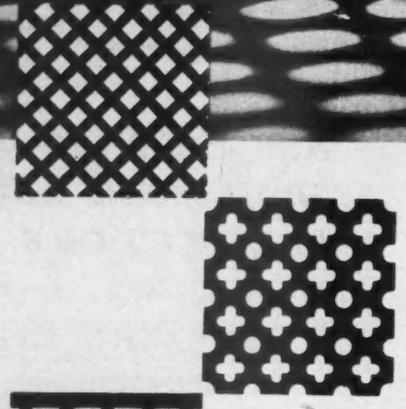

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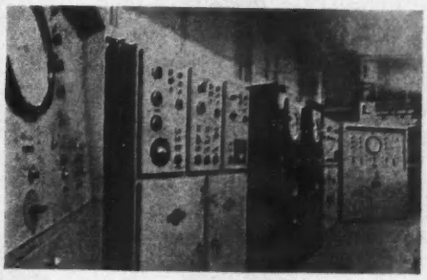
CLEAN HANDLING of grain, coal, alumina, phosphates and other granular materials discharged pneumatically from ships' holds. When suction nozzles like these are at work there is no sign of the disagreeable and sometimes injurious dust raised by mechanical unloading plant.



CLEAN HANDLING of carbon blacks at the India Tyre and Rubber Company's factory at Inchinnan, Scotland. From a bulk intake point the blacks are conveyed to storage hoppers and thence through a weigher hopper direct to the Banbury mixers, by a mechanical handling system operated from control panels

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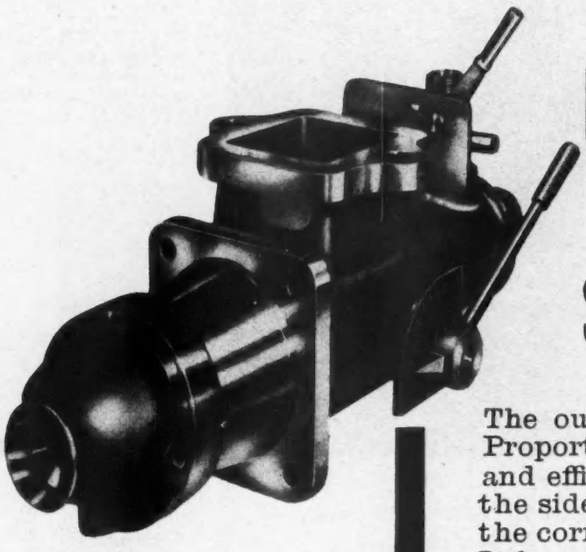

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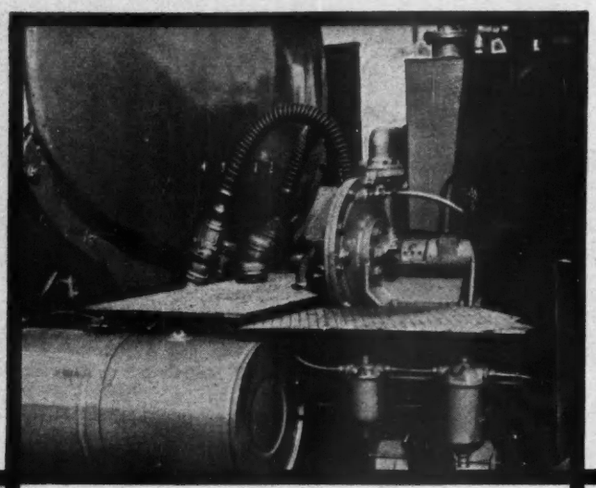

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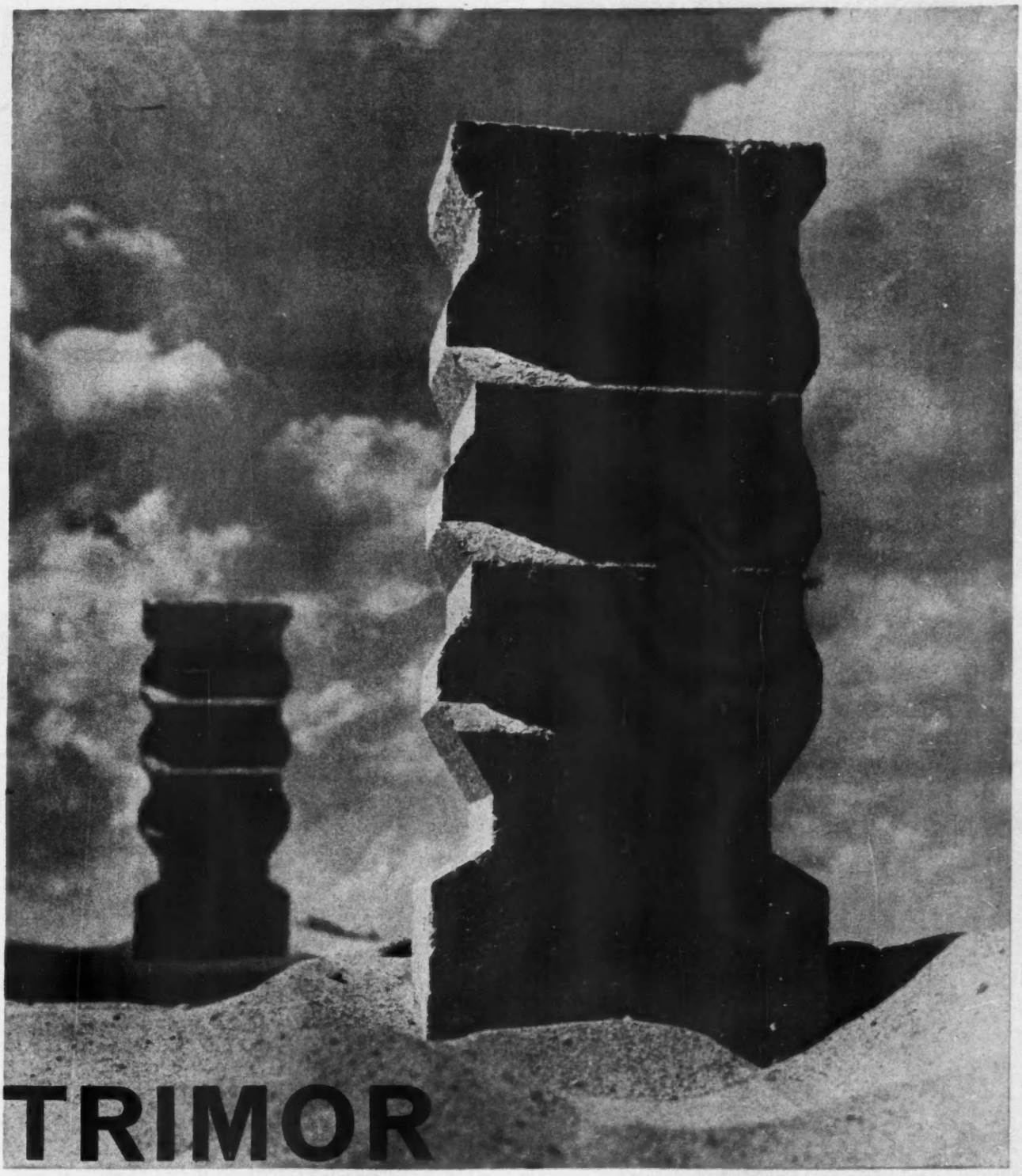

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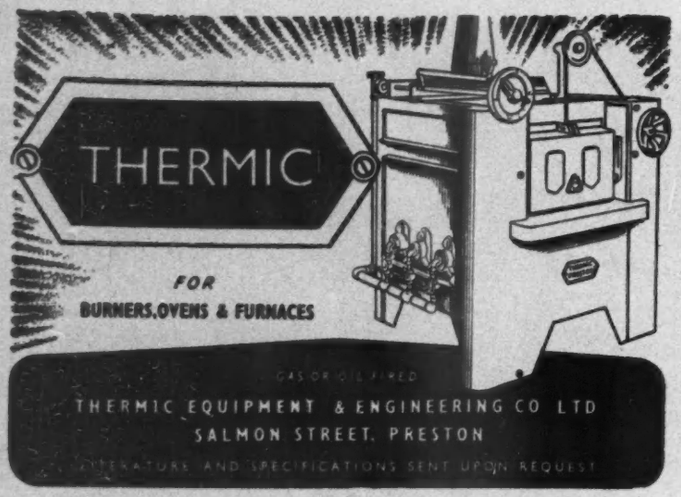

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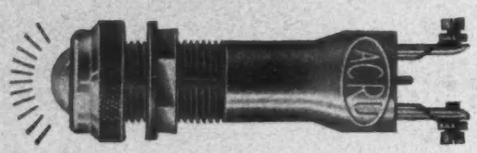

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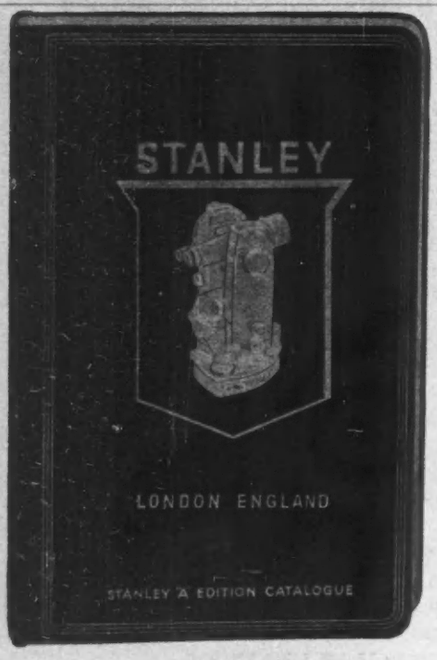

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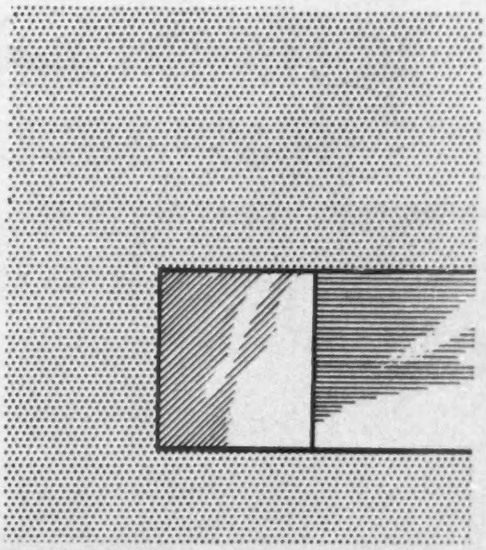

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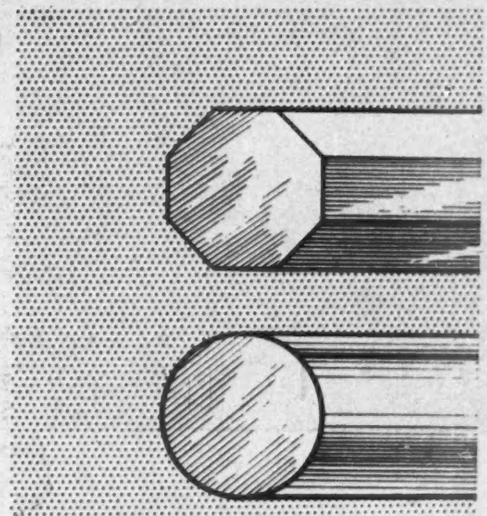

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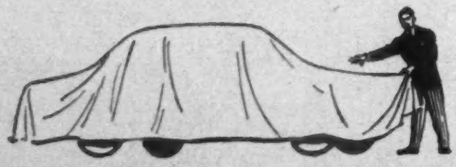

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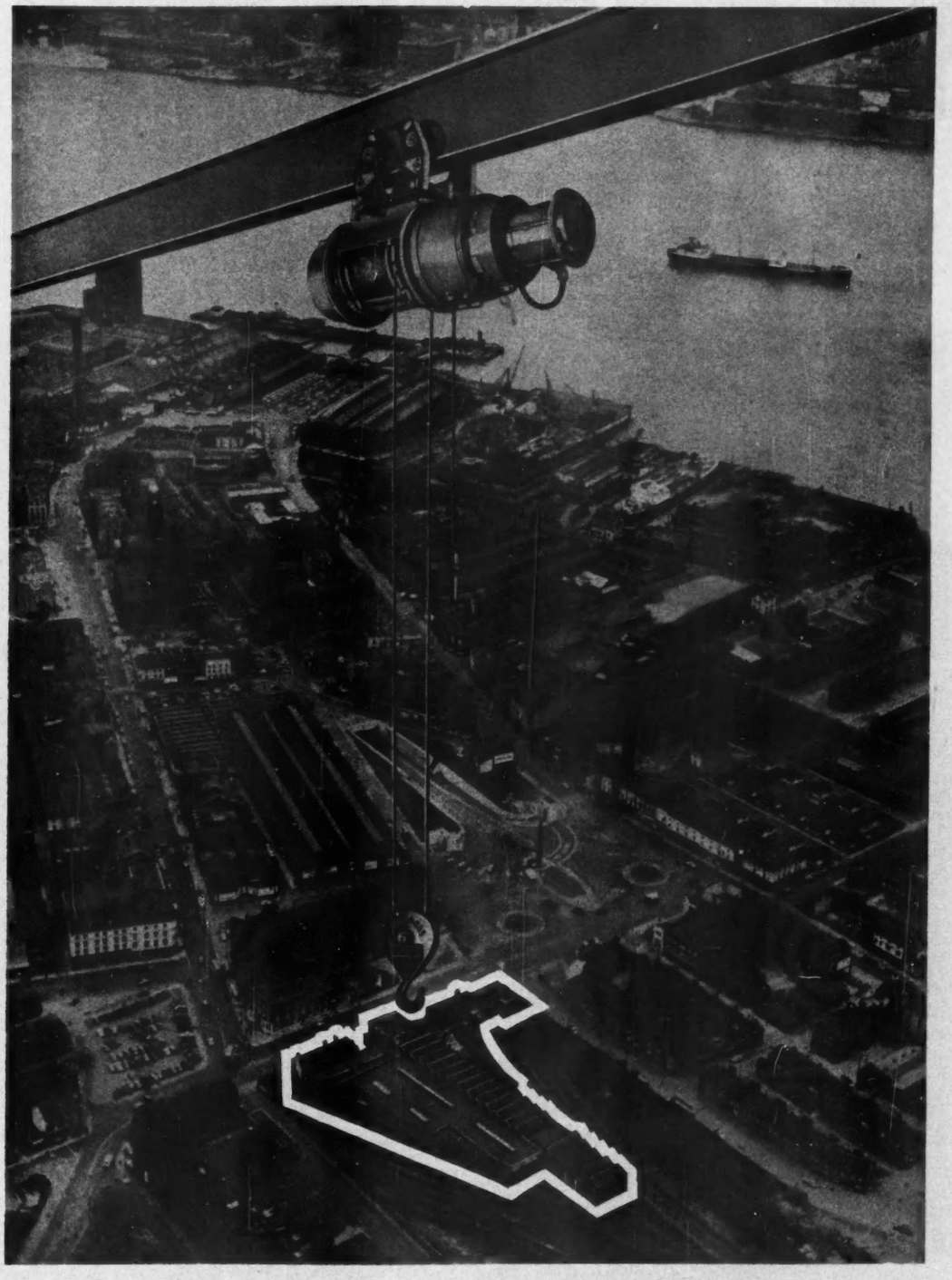

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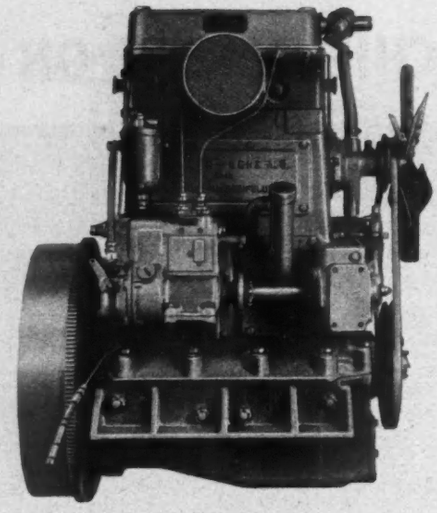

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Types and Performance Data Type	Cooling	No. of cylinders Arrangement	Output PS (DIN)	Speedrange R.P.M.	Cyl. Bore ins.	Stroke ins.	Piston displacement cu. ins.	Weight approx. lbs.
M 202 B	W	2 S	35 – 55	750 – 1200	5 1/2	8 1/4	394.8	1665
M 203 B	W	3 S	54 – 90	750 – 1200	5 1/2	8 1/4	591.9	2150
M 204 B	W	4 S	72 – 120	750 – 1200	5 1/2	8 1/4	789.0	2715
OM 636	W	4 S	17 – 35	1500 – 3000	2 15/16	3 15/16	107.8	495
OM 312	W	6 S	47 – 77	1500 – 2400	3 9/16	4 3/4	279.5	784
OM 321	W	6 S	55 – 94	1500 – 2600	3 3/4	4 3/4	311.2	784
OM 315	W	6 S	80 – 124	1200 – 1800	4 7/16	5 1/2	505.0	1700
OM 326	W	6 S	97 – 155	1200 – 1800	5 3/64	5 1/2	660.0	1720
MB 851	W	1 S	9 – 20	1000 – 2000	4 1/2	5 1/2	88.8	662
MB 861	L	1 S	9 – 20	1000 – 2000	4 1/2	5 1/2	88.8	662
MB 852	W	2 S	18 – 40	1000 – 2000	4 1/2	5 1/2	176.9	915
MB 862	L	2 S	18 – 40	1000 – 2000	4 1/2	5 1/2	176.9	915
MB 853	W	3 S	27 – 60	1000 – 2000	4 1/2	5 1/2	266	1122
MB 863	L	3 S	27 – 60	1000 – 2000	4 1/2	5 1/2	266	1122
MB 854	W	4 V	36 – 80	1000 – 2000	4 1/2	5 1/2	354.4	1245
MB 864	L	4 V	36 – 80	1000 – 2000	4 1/2	5 1/2	354.4	1245
MB 846 A	W	6 S	114 – 250	750 – 1500	5 7/8	7 1/2	1230.2	3860
MB 846 B	W	6 Li	114 – 250	750 – 1500	5 7/8	7 1/2	1230.2	3970
MB 846 Ab	W	6 S	148 – 320	750 – 1500	5 7/8	7 1/2	1230.2	4080
MB 846 Ad ▼	W	6 S	148 – 320	750 – 1500	5 7/8	7 1/2	1230.2	4200
MB 846 Bb	W	6 Li	148 – 320	750 – 1500	5 7/8	7 1/2	1230.2	4200
MB 836 B	W	6 S	240 – 375	1000 – 1500	6 7/8	8 1/16	1806.3	4380
MB 836 Bb	W	6 S	320 – 525	1000 – 1500	6 7/8	8 1/16	1806.3	4830
MB 836 Db ▼	W	6 S	370 – 650	1000 – 1500	6 7/8	8 1/16	1806.3	5050
MB 820 B	W	12 V	460 – 750	1000 – 1500	6 7/8	8 1/16	3612.6	6180
MB 820 Bb	W	12 V	640 – 1100	1000 – 1500	6 7/8	8 1/16	3612.6	6900
MB 820 Db ▼	W	12 V	770 – 1350	1000 – 1500	6 7/8	8 1/16	3612.6	7240
MB 837 A	W	8 V	165 – 440	1000 – 2000	6 1/2	6 7/8	1825	2940
MB 837 Aa	W	8 V	215 – 550	1000 – 2000	6 1/2	6 7/8	1825	3020
MB 835 Ab	W	12 V	840 – 1450	1000 – 1500	7 1/2	9 1/2	4773	8157
MB 835 Bb ▼	W	12 V	1015 – 1780	1000 – 1500	7 1/2	9 1/2	4773	8597
MB 839 Ab	W	16 V	1120 – 2000	1000 – 1500	7 1/2	9 1/16	6380	11020
MB 839 Bb ▼	W	16 V	1350 – 2400	1000 – 1500	7 1/2	9 1/16	6380	11450
MB 518 B ▼ ▼	W	20 V	3000	1720	7 5/16	9 13/16	8201.5	10550

Note

W = water cooling L = air cooling
Li = horizontal S = vertical
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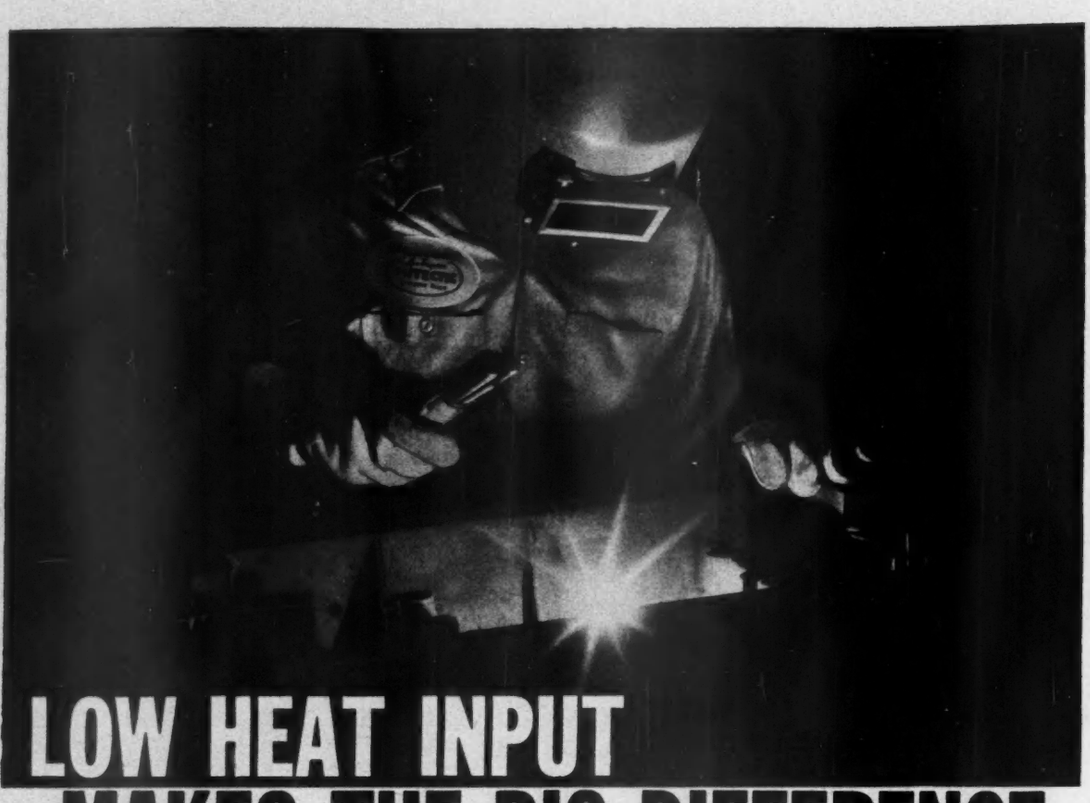

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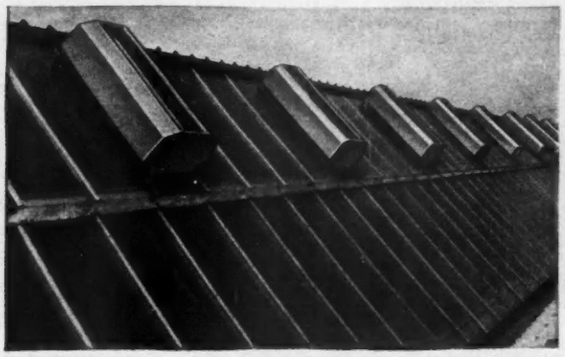

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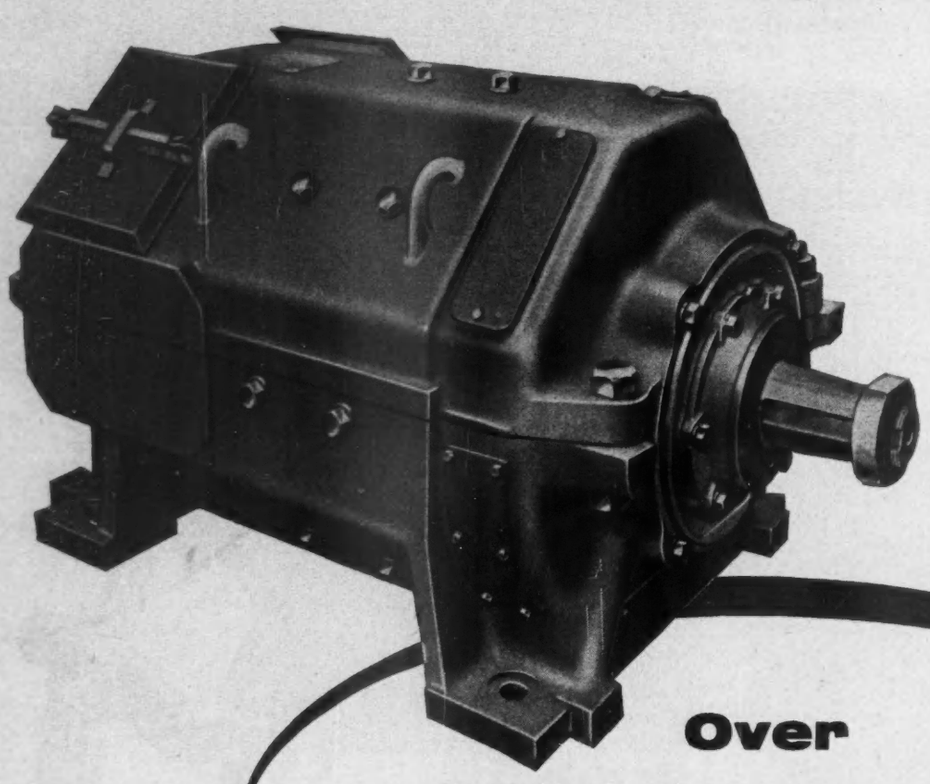

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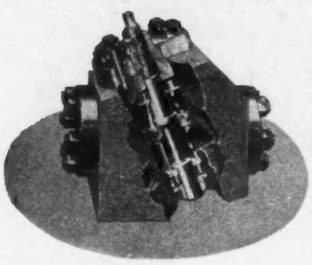
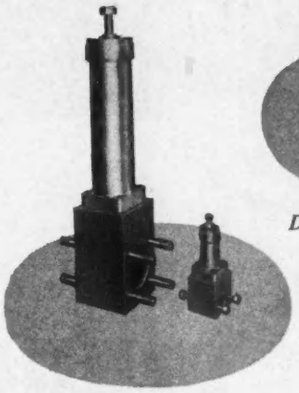
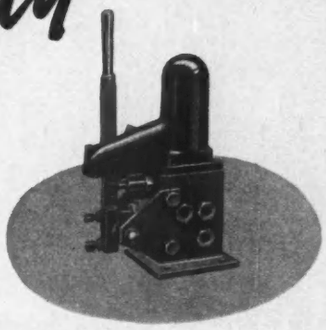


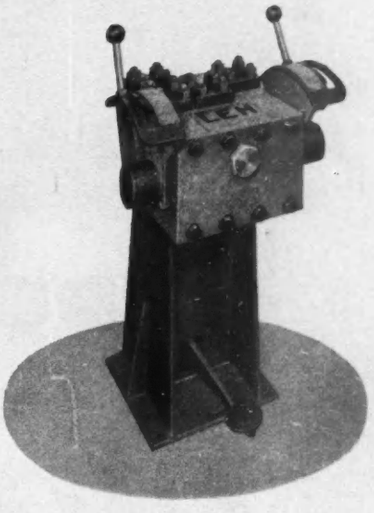
Balanced 'Inline' Stop Valve



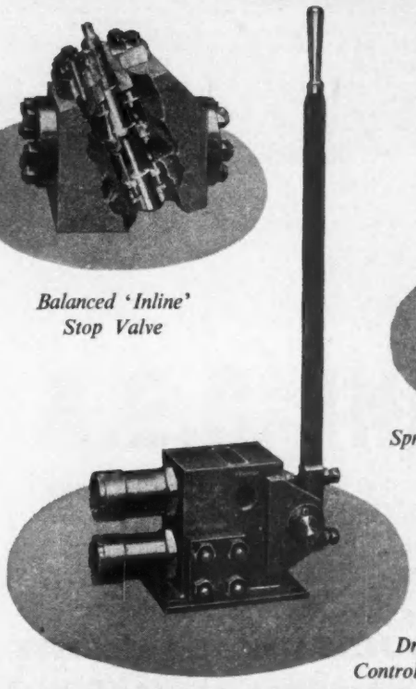
Spring Loaded Relief Valves



Drop Mitre Control Valve With Trip Gear



Piston Type Control Valve



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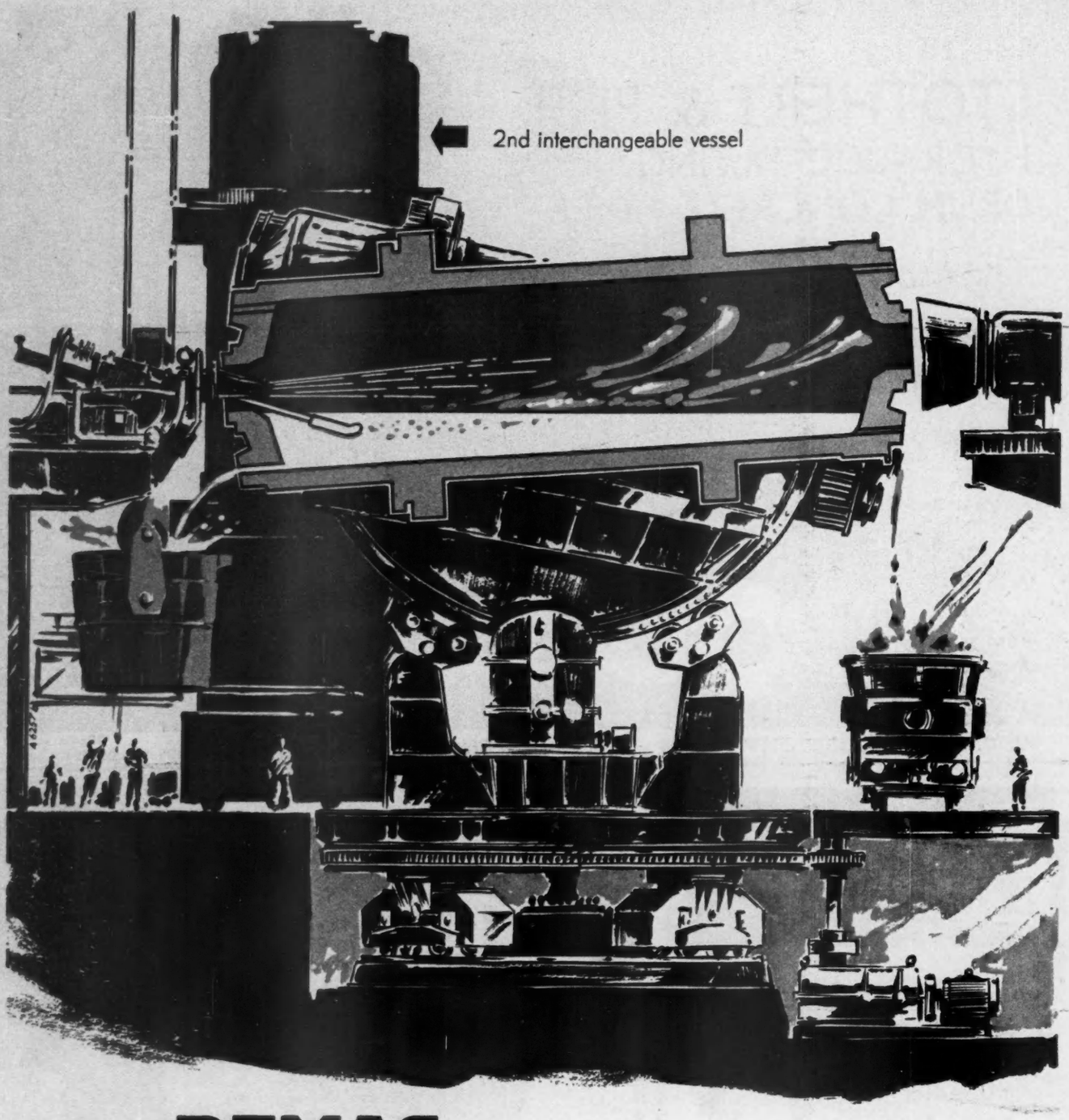

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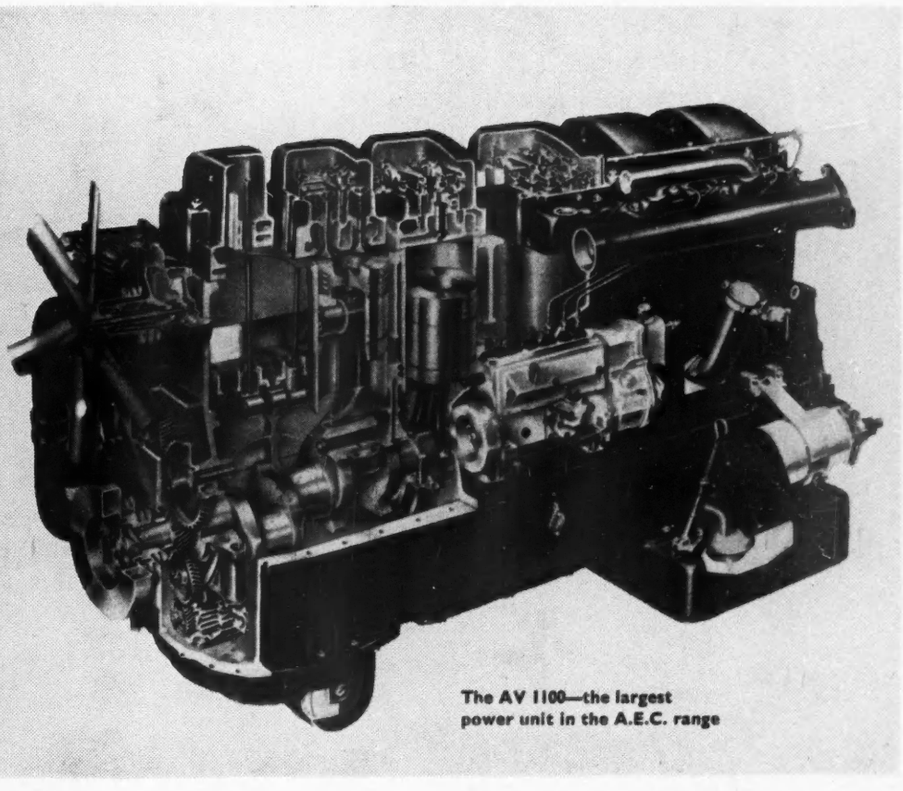

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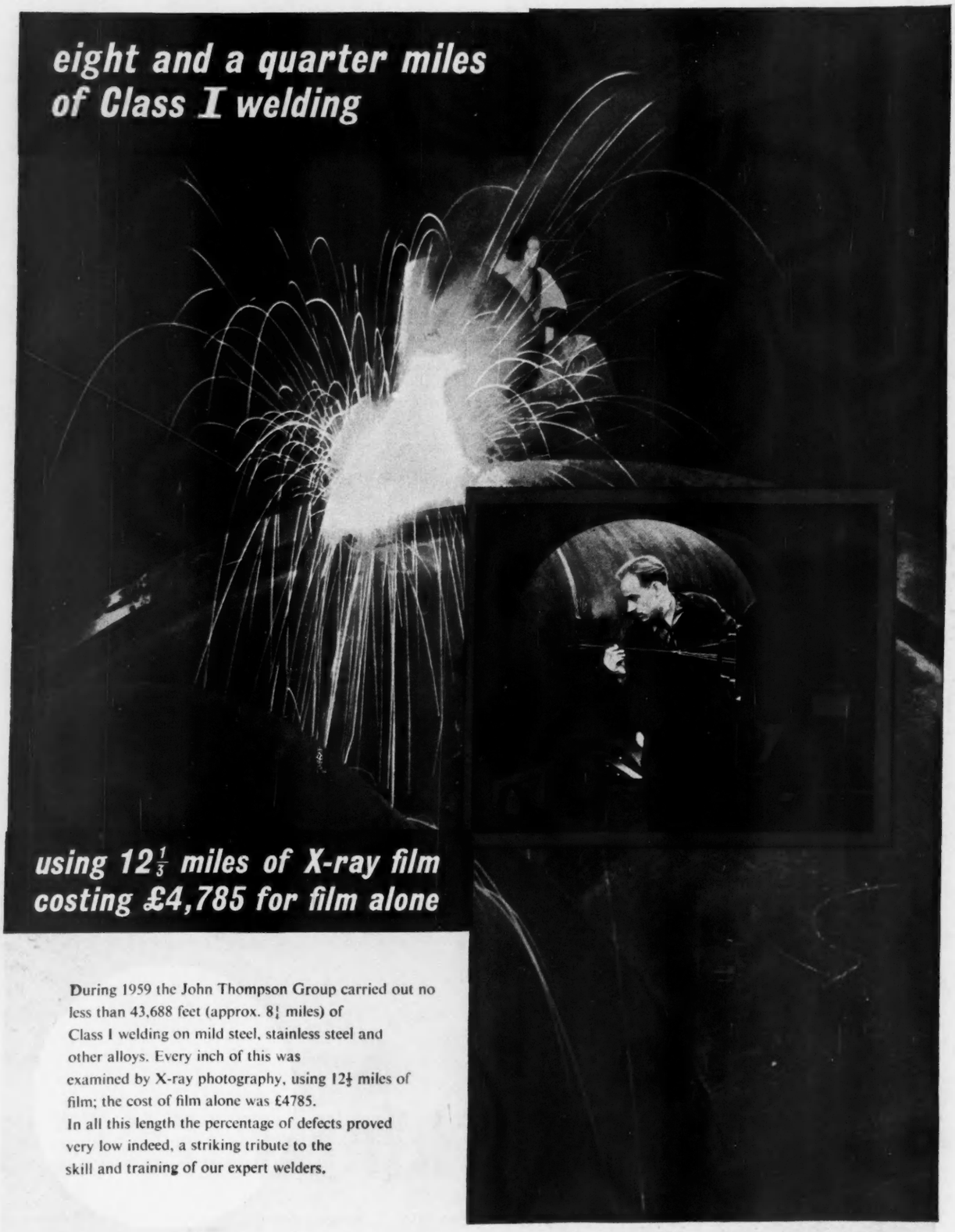

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